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MOSAIC OF THE COMMON COLEUS

D. B. Creager

(Accepted for publication September 15, 1944)

Because of their colorful, variegated, and beautifully shaped leaves, numerous horticultural varieties of *Coleus Blumei* Benth. are used as ornamental plants. Coleus is used extensively as a bedding plant, especially in parks, cemeteries, and home flower beds, and frequently as a house plant. Coleus is not of major importance as a commercial florists' crop, but it does occupy an important place as a minor crop in the florists' industry.

Since it is the shape and colorful pattern of the leaf which make Coleus plants valuable as ornamentals, any trouble that mars the color quality, color pattern, or shape of the leaf seriously affects their decorative and economic value. Such a trouble was found in several varieties of Coleus growing in the Natural History Survey greenhouses in Urbana, Illinois, during the winter of 1941. Affected plants were off color, faded, mottled, and splotched, and the general brilliance and color effect of the planting was altered (Fig. 1, A).

Plants in which this trouble was first discovered had been obtained as cuttings from another greenhouse, and upon examining the source plants the same disease was found. Since its discovery, the malady has been observed in a number of widely separated commercial greenhouses and outside plantings. Since the Coleus is propagated vegetatively by cuttings and has been so extensively shipped, probably the disease is widespread.

At the outset, the symptoms and general nature of this Coleus trouble were suggestive of those caused by virus infection in other plants, yet no such disease of Coleus seems to have been reported. No reference to a virus disease of Coleus appears in the relatively recent compendiums on plant viruses by Smith (7), Holmes (5), Bawden (1), and Cook (2, 3). Price (6) lists *Coleus Blumei* Benth. as being susceptible, upon artificial inoculation, to viruses causing tobacco necrosis, tobacco ringspot, tomato ringspot, cucumber mosaic, and alfalfa mosaic, and Hildebrand (4) reports the plant susceptible to the tomato-ringspot virus. Both Price and Hildebrand considered the host susceptible if the virus could be recovered from inoculated plants, whether or not symptoms of infection occurred. Neither of these workers described the appearance of their Coleus plants following inoculation.

In reference to the possible occurrence of a virus disease in *Coleus Blumei*, Cook (2) stated, "It has been suggested that some of the variegations in this and other species may be due to a virus, but there is no proof." In contrast to the sense of Cook's statement, the effect of the Coleus trouble considered here is to alter or destroy established color patterns rather than to create them.

In allusion to the characteristic symptoms of leaf mottling, this disease is being called Coleus mosaic.

VARIETIES AFFECTED

By examination of plants growing in commercial and experimental plantings during the past three years, 40 varieties appear to be susceptible to Coleus mosaic, as indicated by symptoms. Positive symptoms of Coleus mosaic have been found in the following varieties: Beauty, Beckwith Gem, Big Tim, Brilliancy, Centaur, Chicago Bedder, Coral, Daudet Sport, Defiance Sport, Ella Cinders, Filmore Beauty, Firebrand, Firecrest, Fire Flame, Eldorado, Empress of India, Green and White, Glory of Autumn, Gold Bound, Golden Bedder, Helen, Hollywood, Hurricane, Improved Hollywood, Jewel, LaVerne, Leopard, Lord Alverson, Massey, Mme. Caroline Beck, Mrs. Turner, New Defiance, Rainbow, Red Verschaffelti, Riverside, Rob Roy, Salvador, Setting Sun, Verschaffelti, and Yellow Jack. Cross inoculations, using affected plants of Beauty, Centaur, and Gold Bound as sources of inoculum and clones propagated from selected healthy plants of the Gold Bound variety as test plants, demonstrated that all three varieties were affected with the same disease. From observations and results of experimental studies, apparently many commercial varieties of Coleus are susceptible to Coleus mosaic.

SYMPTOMS

In many respects, the symptoms of Coleus mosaic resemble those expressed in other plants affected with virus diseases, but since leaves of most varieties of Coleus present colors, especially shades and tints of red, other than green, color changes in the leaves of Coleus are strikingly different from those seen in the green leaves of most plants. The most striking symptoms of Coleus mosaic are those connected with changes in foliage color.

Since there are so many varieties of Coleus, each with its own color pattern, a description of color changes due to Coleus mosaic cannot be given for all of them. In some varieties the color change symptoms are clearly expressed, but other varieties have leaves so elaborately variegated that these symptoms are quite obscure or masked. Since symptoms involving color changes show quite clearly in the leaves of the Gold Bound variety and since that variety was used in transmission studies described later, this discusssion of symptoms of Coleus mosaic will be restricted, for most part, to that variety.

Gold Bound leaves are large and their color pattern is simple (Fig. 1, B). They are deep maroon with a chartreuse green edging above and uniformly willow green below. When affected with mosaic, they lose their brilliance and their uniformly lustrous maroon upper surface becomes mottled or splotched with light or dark maroon, brownish, bronze, greenish, reddish, yellowish, and whitish areas (Fig. 2). Also, the discolored areas often assume such forms as zonal ring spots, oak leaf patterns, and irregular, zigzag, or hieroglyphic markings.

Ring spots can be dark, almost black-red or maroon in the center, surrounded by lighter red or maroon zones, or dull, brownish red in the center, surrounded by one or several light greenish lines or zones. Oak-leaf patterns

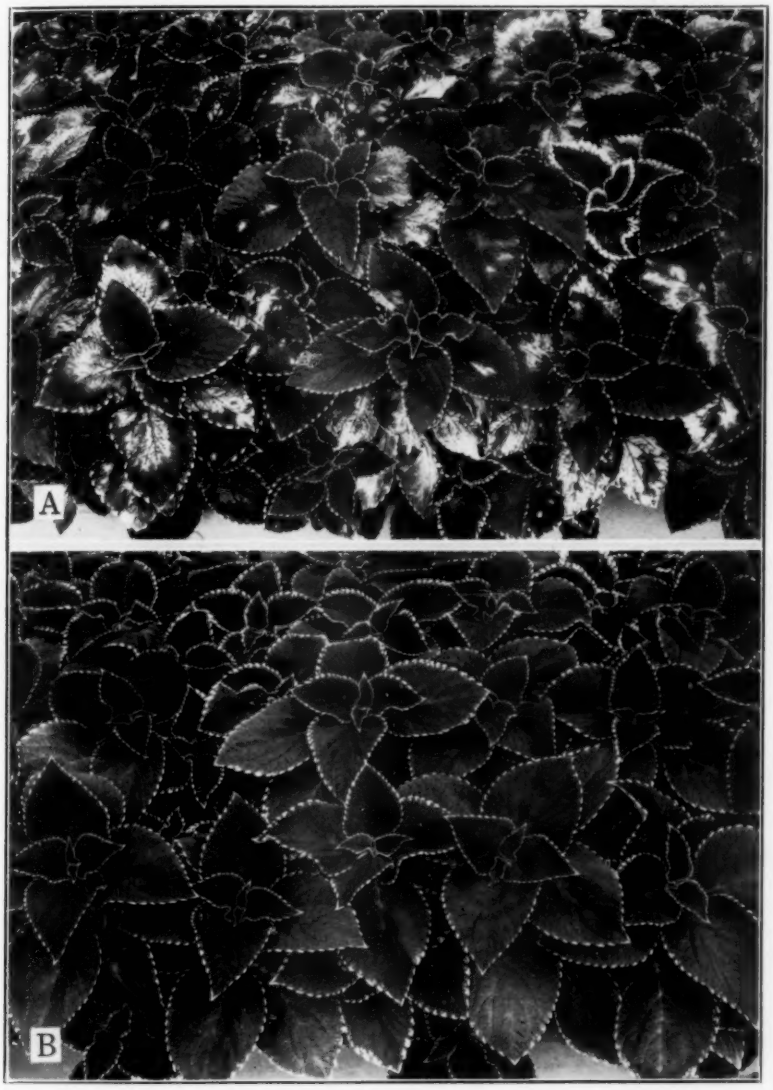

FIG. 1. Coleus mosaic in the Gold Bound variety. A. Mosaicked plants showing typical mass effect of the disease on shape and color pattern of leaves. B. Healthy plants showing typical shape and color pattern of the leaves.

are similar to the ring spots, in that the zigzag area across the leaf is lighter maroon, dull greenish red, brownish green, green, or yellow. Different zones of all gradations of colors can be present in one pattern. Leaves with this pattern are usually lighter maroon, yellowish or dull greenish red towards

the base and black-red or darker maroon than normal just beyond the pattern towards the tip of the leaf. Clearing of veins, especially of the maroon color, is usually present in the oak-leaf pattern, the cleared veins radiating marginward in the midrib and most prominent lateral veins. Vein clearing

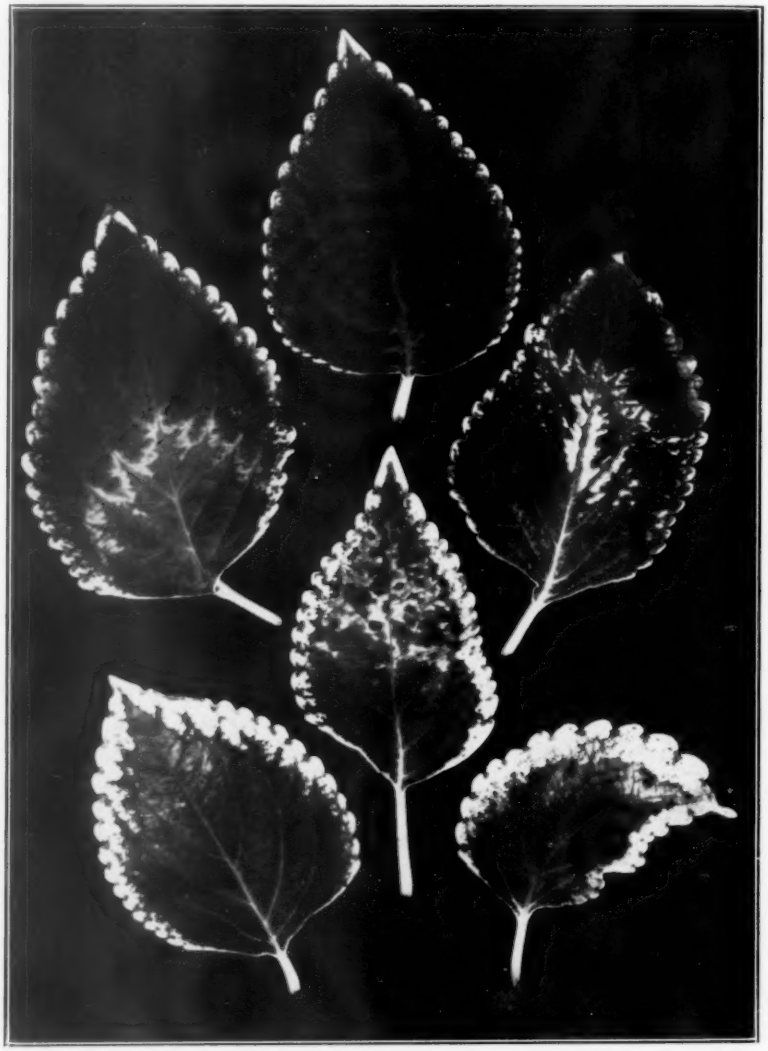

FIG. 2. Effect of Coleus mosaic on Gold Bound leaves. At the top, a normal leaf; below it, five leaves showing oak-leaf patterns, mottling, vein-clearing, fading, and malformation.

also occurs on mottled leaves, although less frequently than on those with the oak-leaf pattern or irregular, stellate ring spots.

Necrotic lesions are not common, but occasionally scattered spots $\frac{1}{8}$ to $\frac{3}{4}$ inch across occur on leaves of affected plants during the winter months and

early spring. These lesions can be simple spots, or they can be circular to stellate, zonal ring spots. The centers of ring spots can be necrotic, or of living green tissue, surrounded by a series of several discontinuous necrotic lines. The color of the necrotic tissue is blackish brown to black.

Affected leaves are often puckered, asymmetric, and rugose (Fig. 2). Puckering and crinkling are often associated with the occurrence of oak-leaf markings, large ring spots, and other strongly marked patterns. Frequently, affected leaves are stunted; occasionally, branches are markedly stunted; and, least often, entire plants are stunted and distorted.

TRANSMISSION STUDIES

Since all known plant viruses can be transmitted by grafting, the graft method was used to determine whether or not Coleus mosaic is caused by a virus. Healthy plants of the Gold Bound variety, all members of the clonal progenies of five healthy individuals, were used as understocks, while shoots taken from diseased plants were used as scions. In both series of grafting tests, the first in January, the second in June, 1942, the cleft graft was used. The stock plants, which averaged approximately 8 inches in height, were prepared for grafting by removing the tops of the plants, 3 to 5 inches below the tips. Then the top of the remaining stem was split down the middle for about an inch. The scion, a shoot taken from a diseased plant with its base trimmed to a wedge, was inserted into the split of the stock and lightly bound in with wrapping cord. The grafted plants were kept in a shaded moist chamber in the greenhouse for about 7 days, until union of scion and stalk was established.

The first series consisted of 28 graft-inoculated plants and a number of comparable check plants to which no scions were grafted. Typical symptoms of Coleus mosaic developed in the Gold Bound foliage of 24 of the grafted plants, but no symptoms appeared in the check plants.

The second series consisted of 75 graft-inoculated plants with an equal number of comparable check plants, the checks being derived by rooting the tops of the plants to which scions were grafted. All 75 grafted plants became infected, producing typical symptoms of Coleus mosaic, and all checks remained healthy.

The first indications of transmission became noticeable approximately 3 weeks after grafting. The earliest symptoms, in most cases, appeared in the young leaves of lateral shoots originating just below the graft union. In many of the grafted plants systemic infection appeared to progress through two stages. These two stages were not observed in all cases, but when they did occur the first stage symptoms consisted of narrow, necrotic lines forming ring spots and other irregular markings in leaves, in the main stem of the stock just below the graft, and in lateral branches of the stock originating near the union. In leaves the lines were very narrow and usually appeared as a series of zigzag parallel lines or ring spots. These lines seemed to have little or no relationship with the vein structure of the leaf,

some crossing the veins at right angles, others crossing them diagonally, and still others paralleling them. These necrotic lines in leaves usually did not develop into the marked necrotic spots which sometimes develop in plants in which systemic infection has been established. In stems, the zigzag lines would sometimes completely surround the stem, but more frequently they would be restricted to one side only, these lesions occurring as single lines or as wave-like series of parallel, parabolic lines. Occasionally, lines in the stem developed into broad necrotic areas, sometimes of such an extent that small branches near the graft union were killed and rather frequently the scion was killed as a result of the complete necrosis occurring at or just below the graft union. Such stem lesions have not been observed in diseased plants found in nature and have not been observed in plants propagated as cuttings from graft-inoculated individuals.

Second-stage symptoms occurred soon after the appearance of the first in the form of characteristic color-fading, mottling, splotching, and formation of oak-leaf patterns and ring spots. Symptoms were, in general, like those in diseased plants from which the scions were originally taken. These second-stage symptoms appeared in all graft-inoculated plants which became infected, but were not always preceded by the first-stage symptoms. After they appeared, symptoms identical with those developed in the first stage did not continue development or recur.

The infective principle has been transmitted not only from the original diseased plants to healthy plants but also from graft-inoculated plants to healthy plants. Further, it has been carried repeatedly from one generation of plants to the next in cuttings taken both from graft-inoculated plants and from originally diseased individuals. The results of these studies clearly indicate that Coleus mosaic is caused by a transmissible virus.

Thus far, all attempts to transmit the Coleus mosaic virus mechanically from diseased to healthy plants have failed. Freshly expressed juice from infected plants, rubbed on leaves of healthy Coleus and Turkish tobacco, with or without the use of carborundum powder, gave no symptoms of infection on either plant. Likewise, when expressed juice was injected with a hypodermic needle into veins, petioles, and young stems of healthy Coleus plants, no evidence of transmission resulted.

Since Coleus mosaic occurs in some plantings but not in others, and since it has been found in many different varieties in those plantings where it occurs, there must be some natural method of virus transmission. When a block of several hundred healthy stock plants and a block of diseased plants were grown side by side in pots on a greenhouse bench, positive indications of transmission appeared. Three plants belonging to two different clonal progenies of healthy plants, adjacent to the block of diseased plants, became infected. Also, at the opposite end of the block of healthy plants, nine other plants representing clonal progenies of four healthy individuals became diseased. This transmission occurred only in the two restricted areas, and only part of the plants representing any one clone became infected. These

observations, coupled with the failure of attempts at mechanical transmission, suggest that insects may be the natural agents of transmission.

SUMMARY

Coleus mosaic, a disease causing mottling, splotches, ring spots, oak-leaf patterns, and hieroglyphic markings on leaves, has been found in a number of greenhouse and outside plantings of Coleus.

Indications are that Coleus mosaic is widespread and that many commercial varieties of Coleus are susceptible.

Grafting tests have clearly proven that Coleus mosaic is caused by a transmissible virus.

Observations made in experimental and commercial plantings indicate that there is some natural means of spread of the Coleus mosaic virus. Since all attempts to transmit the virus mechanically have failed, it is suggested that insects might be vectors.

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URBANA, ILLINOIS.

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RHIZOCTONIA NECK ROT OF GLADIOLUS

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(Accepted for publication November 1, 1944)

For several years a neck rot of gladiolus has been under observation and study in the commercial gladiolus-growing area of Kankakee County, Illinois. This disease occurs in scattered plantings being grown from cormels. It destroys the plants in long, continuous sections of the rows (Fig. 1). It generally appears early in May. As the season progresses, the affected sections of the rows grow longer and longer, some of them reaching six to seven feet at the time the corms are ready for harvesting.

Fig. 1. Gladiolus plants, Opalescent variety, affected with Rhizoctonia neck rot, showing a typical section of a row in which the plants have been killed; natural inoculation.

In the majority of plantings in which the disease has been observed, estimated losses have been less than 25 per cent, but nearly complete destruction of plantings of some varieties has been observed in several instances, especially where several spots of infestation occurred in the rows within a few feet of each other.

Neck rot has appeared in plantings made both on land where gladiolus had not previously been grown and on land where they had been grown for years. Little, if any, difference in the frequency of occurrence of the disease under the two conditions was observed. Severe infection was observed in Rewi Fallu, Picardy, Giant Nymph, Opalescent, Pearl Harbor, Dr. F. E. Bennett, and Flaming Sword varieties. In one planting, the Queen of Bremen variety showed no signs of infection although it was growing alongside other varieties which were severely affected, indicating that it might be resistant to the malady.

Infection occurs in the basal parts of the leaves (Fig. 2, B and C), about one inch below the soil surface, causing lesions which are at first soft and

FIG. 2. Gladiolus plants, Picardy variety, affected with Rhizoctonia neck rot; artificial inoculation. A. A short section of a row in which the plants adjacent to the point of inoculation have been killed. B. Necrotic lesions on leaf bases; a typical disintegrated, shredded leaf at left. C. Corm lesions at points of scale attachment, giving the corm a horizontally striped appearance. All inoculated August 3, 1940; photographed October 1, 1940.

hydrotic, later brown and necrotic. Eventually the bases of infected leaves are shredded, because of disintegration of the succulent parenchyma tissue between the veins. Basal infection of the leaves usually causes wilting and ultimate death of the entire above-ground portions of the plant. However, when large plants become infected, only the outer leaves may be killed or the necrotic lesions may fail to bring about the death of the infected leaves.

Occasionally, leaf sheaths and corm scales on affected plants are destroyed, and long, narrow, brown lesions develop on the corms where the infected scales were attached (Fig. 2, C). These lesions give the corm a horizontally striped appearance. When the top of the plant has been killed, corm development ceases. Consequently, the earlier infection occurs the greater is its effect. At harvest time, one commonly finds no corms, or very small ones, where infection occurred early, but finds progressively larger corms where infection occurred at later times.

If the dead tops are carefully lifted from the soil, a characteristic cobweb-like mycelial growth, to which sand and soil particles cling, is almost always found on them. Its presence aids in diagnosing the trouble, since microscopic examination and cultural studies have shown it to be the mycelium of the pathogen which causes the disease.

A fungus of the genus *Rhizoctonia* has been consistently isolated from fresh lesions on affected leaf bases. Microscopic and cultural comparisons of this fungus with cultures of *Rhizoctonia solani* Kühn isolated from potatoes, poinsettia, and carnations indicate that it is at least a strain of the same species.

Inoculations on plants grown in the greenhouse and on plants in the field have produced typical symptoms of the disease in the Picardy and Rewi Fallu varieties. Pieces of agar medium or barley grains, in which the fungus was growing in pure culture, were placed against the bases of the plants just below the soil surface. The first symptoms of infection appeared within seven days after inoculation, showing on young plants as hydrotic lesions and causing sudden wilting and death of the leaves (Fig. 2, A). On larger, older plants symptoms appeared as large necrotic lesions in the leaves (Fig. 2, B). In these artificial inoculations, the pathogen spread in the row from plant to plant, giving rise to dead sections in general resembling those seen under natural conditions. Typical lesions developed in the scale attachment areas on the corms of many of the infected plants (Fig. 2, C).

The pathogen was readily isolated from the inoculated plants, thus completing good evidence that neck rot of gladiolus is caused by a strain of *Rhizoctonia solani* Kühn.

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SELENOPHOMA BROMIGENA LEAF SPOT ON BROMUS INERMIS[1]

J. LEWIS ALLISON

(Accepted for publication November 17, 1944)

INTRODUCTION

Smooth bromegrass, *Bromus inermis* Leyss., has become an important forage and pasture grass in the North Central States since 1930. This paper presents work on a leaf spot disease destructive to the foliage of *B. inermis* in nurseries at University Farm, St. Paul, Minnesota. Studies pertinent to the cultural characteristics of the causal organism have been reported by the writer (1, 2).

THE DISEASE

History, Distribution and Description

The causal organism was identified as *Septoria bromigena* Sacc. (9). It was first described and named from diseased plants collected by Brenckle (4) in North Dakota in 1918. In studies on *Septoria spp.* on Gramineae in the Pacific Northwest Sprague and Johnson (10) have determined that species with nonseptate, falcate spores, borne in small globose pycnidia, with coarse globose peridial cells, are more logically assigned to *Selenophoma* Maire than to *Septoria* Fries. Accordingly, *Septoria bromigena* becomes *Selenophoma bromigena* (Sacc.) Sprague and Johnson.

Selenophoma was collected in many localities in Minnesota, Wisconsin, North and South Dakota, and Manitoba. The disease has been reported by Fischer *et al.* (8) as "almost universal east of the Rockies except in the drier areas."

Symptoms produced by *Selenophoma* on *Bromus inermis* are very similar to those caused by species of *Septoria* attacking other gramineous hosts. Soon after growth starts in the spring, oblong chlorotic lesions from 8 to 15 mm. long appear on the lower leaves of infected plants. After about seven days lesions are light brown and dry at the center with a light red border. Numerous pycnidia appear in these dried areas after 12 to 14 days. The infected leaves turn yellow and often die prematurely. Severe leaf infection frequently results in almost complete defoliation. Ordinarily infection occurs only on localized spots on the leaves, but under favorable environmental conditions the infected areas may coalesce and cover large portions of the leaf surface. At such times infection often spreads to the sheath, stem, rachis, panicles, and glumes. Severe attacks stunt the plants and may even kill them. *Selenophoma bromigena* usually occurs alone on the host although other foliage diseases sometimes are found with leaf spot. Typical symptoms of leaf spot on *B. inermis* caused by *S. bromigena* are shown in figure 1, A.

[1] Summary of a thesis presented in partial fulfillment of the requirements for the degree Doctor of Philosophy, granted by the University of Minnesota, June 1940.

Paper No. 2189 of the Scientific Journal Series, Minnesota Agricultural Experiment Station.

Description of the Pathogen

The pycnidia of *Selenophoma bromigena* are small, black, subepidermal, and globose with coarse globose peridial cells. They are 80 to 110 microns in diameter. The conidia are cylindrical, hyaline, slightly guttulate, non-septate, and multinucleate. They are 3 to 3.5 by 22 to 27 microns.

Host Range of the Pathogen

Selenophoma bromigena has been reported by Fischer (7) on *Bromus arvensis*. This was the only report found in the literature listing *S. bromigena* on any host other than *B. inermis*. To gain some knowledge of the host range the following species of brome and other grasses as well as a few cereals were tested for their reaction to artificial inoculation with the organism: *Bromus anomalus* Rupr., *B. arvensis* L., *B. brizaeformis* Fisch. and Mey., *B. carinatus* Hook. and Arn., *B. ciliatus* L., *B. erectus* Huds., *B. inermis* Leyss., *B. japonicus* Thurb., *B. laevipes* Shear, *B. lanuginsosus* Pair, *B. macrostachys* L., *B. madritensis* L., *B. marginatus* Nees., *B. mollis* L., *B. polyanthus* Scribn., *B. racemosus* L., *B. rigidus* Roth, *B. rubens* L., *B. secalinus* L., *B. tectorum* L., *B. vulgaris* (Hook) Shear, *Agropyron cristatum* (L.) Gaerth, *A. inerme* (Scribn. and Smith) Rybd., *A. trachycaulum* (Link) Malte, *A. repens* (L.) Beauv., *A. Smithii* (Pursh) Scribn. and Smith, *Elymus canadensis* L., *E. glaucus* Buckl., *Hordeum jubatum* L., *H. nodosum* L., *Poa compressa* L., *P. pratensis* L., *Sitanion hystrix* (Nutt.) J. G. Smith, *Hordeum vulgare* L., barley varieties Glabron and Velvet, *Avena sativa* L., oat varieties Bond and Victoria, *Secale cereale* L., rye variety Rosen, and *Triticum vulgare* Vill., wheat varieties Marquis and Thatcher.

Inoculations were made in the greenhouse and in the field on young seedling plants and again on the same plants at about heading time by atomizing the foliage with conidial suspensions of the organism. Potted plants were inoculated, placed in a moist chamber for four days and then removed to a greenhouse held at approximately 65° F. Field plots were covered with muslin cages that were kept wet for four days following inoculation, and the muslin was then removed. Inoculations were made during cool, cloudy weather when the temperature did not exceed 70° F.

In these experiments *Bromus inermis* was the only host that became infected and developed lesions producing mature pycnidia.

Survival of the Pathogen

Septoria in leaf spots on cereals and forage grasses has been reported by Weber (11) to survive the winters by means of conidia retained in mature pycnidia. To determine how long the conidia of *Selenophoma bromigena* remain viable, dried foliage bearing many mature pycnidia was placed out-of-doors in a dry place. Germination of conidia was tested monthly. The rate of germination varied only slightly from month to month and a high percentage of conidia were still viable when the test terminated after 18 months. When mature pycnidia were placed in water drops on microscope

slides, conidia exuded in a gelatinous matrix, which fixed the conidia to the slides when dry. Conidia remained viable for six months on slides stored at 5° C. but less than one month at room temperature. Under natural conditions it is unlikely that conidia would be retained within their gelatinous matrix for long periods and the chances of their surviving variable weather conditions would be slight unless they remained inclosed in a pycnidium.

Dissemination of Inoculum

Many pycnidia dropped from mature lesions when the infected parts of the plant became dry and brittle. To determine if these pycnidia, free from plant material, were disseminated by the wind, microscope slides were coated with a thin film of vaseline and exposed on wind vanes at various distances from centers of heavy infection. Many pycnidia were collected on slides exposed one-half mile from any known infected plants, and it is probable that the pycnidia may be carried greater distances, accounting for much spread of the disease. Pycnidia and conidia are also splashed about by rain which accounts for local spread of the disease. The pycnidia may be seed borne in cases following severe infection when the fungus fructifies on the glumes, as *Selenophoma bromigena* has been isolated from such seed. The caryopsis of *Bromus inermis* is enclosed in the lemma and palea in commercially threshed seed and although floral bract infection is the exception rather than the rule it seems probable that the fungus is carried from one region to another in seed lots.

Germination of Conidia

Tests were made to determine the relationship of temperature to conidial germination and germ-tube elongation. Pycnidia scraped from natural lesions and from agar cultures were washed into tubes of sterile distilled water. Conidia were exuded from the pycnidia in large numbers. Drops of the conidial suspensions thus secured were transferred with a wire loop to cover slips inverted over van Tieghem cells in Petri dishes. A selected standard loop was used to transfer all drops to insure uniform size. The hanging drops of conidial suspensions were then incubated at temperatures ranging from 5° to 35° C. At regular intervals, 100 conidia were selected at random near the periphery of each drop and the germination was observed. The minimum temperature for conidial germination in distilled water was between 3° and 5°, the optimum between 19° and 22°, and the maximum between 30° and 35° C.

Above 30° and below 5° C., the germ tubes formed by conidia in water were very short and knotted. They often ruptured and extruded their protoplasm into the water drop. A similar phenomenon was reported by Caldwell (5) in germination studies of *Rhynchosporium*.

Conidia placed on the surface of drops of water agar inverted over van Tieghem cells and incubated at the optimum temperature, germinated after 12 hours. The conidia usually produced germ tubes from each end, or

occasionally from one end, and the original spore remained recognizable for some time. Darley (6) reported that conidia of *Selenophoma bromigena* germinated on nutrient media form septate hyphal segments very early in the process of germination.

To determine if light was necessary for germination, suspensions of conidia in hanging drops were placed in complete darkness. Conidia germinated as readily in complete darkness as in daylight. Conidia were placed in varying dilutions of extracts made from leaves of susceptible and resistant brome plants but none of the extracts tried affected either the time required for germination or the final percentage of conidia that germinated.

PATHOLOGICAL HISTOLOGY

The relationship of *Selenophoma bromigena* to the host tissues and the development of the disease was studied microscopically, using leaves of *Bromus inermis* naturally infected in the field and infected as a result of artificial inoculation in the greenhouse. Stages in the development of the disease were followed from penetration of the host to the complete breakdown of the leaf tissue and fructification of the pathogen. Germination of conidia, formation of appressoria, and penetration of the cuticle were studied in segments of whole leaves cleared in acetic alcohol and stained with methyl blue. The conidia and germ tubes were heavily stained while the host tissue remained clear.

Penetration was observed through both upper and lower surfaces of the leaf, but more infection occurred on the upper surface. Conidial germ tubes were never observed to penetrate the leaf through the stomata. In fact, germ tubes were observed growing across stomata to form appressoria elsewhere on the epidermal wall. The germ tubes formed small rounded structures at their ends and these functioned as appressoria. The cuticle was penetrated within 48 hours. The penetrating hyphae ramified through the subcuticular region and between the cells of the epidermis. The outer epidermal wall collapsed first, then followed breakdown of the entire epidermal cell. The mycelium then began to grow intercellularly into the mesophyll from the stroma that had been formed. Mesophyll cells broke down rapidly, often slightly in advance of the invading mycelium.

The earliest evidence of infection appeared 7 to 8 days after inoculation, when chlorotic areas were noted at the points of infection. The time required for reproduction of the pathogen, from inoculation to formation of pycnidia containing mature conidia, was from 12 to 15 days.

Fructification occurred after the complete breakdown of the leaf tissue in the infected spot. During the invasion and breakdown of the mesophyll the subcuticular mycelium developed rapidly and formed a stroma several cells thick beneath the ruptured cuticle. The pycnidia were formed superficially among the cells of the stroma after the mycelium had advanced into the mesophyll. Pycnidia were abundant in the central and completely collapsed area of the leaf spot. The fungus did not grow through the leaf

to fruit on the opposite surface. Fructification on both surfaces of a given leaf area occurred apparently only when separate infections developed on opposite sides of the leaf.

FACTORS AFFECTING DISEASE DEVELOPMENT

The Selenophoma leaf spot appeared early each spring. Heavily infected leaves of *Bromus inermis* with lesions bearing newly formed mature pycnidia were collected from nursery rows on March 15, 1938, at St. Paul. The disease developed rapidly during April, May, and early June. During the summer there were relatively few leaf spots, but many appeared during September and October.

In controlled tests the optimum temperature and humidity relationship for infection and development of the disease were determined. The optimum temperature ranged between 15° and 25° C. A film of water on leaves at the time of infection and continued high humidity favored rapid development. Above 28° or below 8° C. only slight infection resulted from artificial inoculation, and the development of the disease was noticeably checked when the temperature rose above 30° C. Thus cool, moist conditions were necessary for infection, rapid development, and spread of the disease.

PHYSIOLOGIC SPECIALIZATION

Monoconidial cultures of *Selenophoma bromigena* isolated from diseased smooth brome plants collected from various regions in Minnesota were tested for pathogenic differences. Seedling and adult plants from seed of open-pollinated and selfed lines of *Bromus inermis* were artificially inoculated. One culture caused severe infection on seedling and adult plants from open-pollinated lines whereas the cultures from the other regions, although pathogenic, caused much less infection. The culture that was most pathogenic on open-pollinated lines was also pathogenic on selfed lines which were resistant to the other cultures.

These results indicate that at least two pathogenically specialized races of *Selenophoma bromigena* exist in nature. Differentially parasitic races in the genus *Septoria* have been reported by Beach (3), but this is the first known record of physiologic races in the genus *Selenophoma*.

Culture Study

Several hundred monosporous isolates of *Selenophoma bromigena* were cultured during this investigation. Single conidia were isolated by means of a micro-manipulator. Each conidium was placed on a small sterile drop of potato-dextrose agar on the lower surface of a cover slip mounted on a van Tieghem cell. When germinated, usually within 48 hours, each isolate was transferred to a 125-cc. Erlenmeyer flask containing 30 cc. of potato-dextrose agar (390 g. potatoes, 20 g. dextrose and 15 g. agar per liter).

When cultures were grown at temperatures ranging from 5° to 30° C. the optimum for growth of the fungus was between 20° and 25° C. As this

range approximates room temperature all later culture studies were at room temperature.

All cultures produced aerial mycelium sparingly and growth consisted of intertwining mycelium which formed tough, leathery mycelial mats that often became rough and convoluted. Pycnidia first appeared in the central part of the mat after 15 to 20 days and gradually formed over the entire

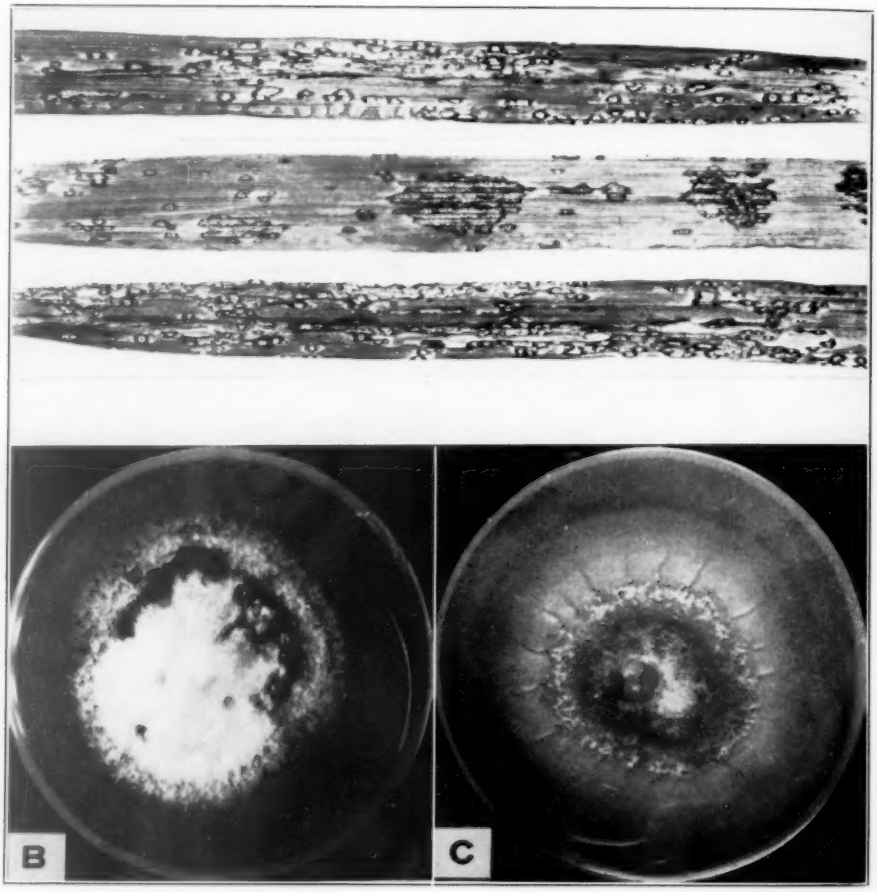

FIG. 1. *Selenophoma bromigena.* A. Typical lesions showing pycnidia on blades of smooth bromegrass. B. A monosporous culture showing the development of a mycelial variant. C. A morphologically distinct variant produced by a monosporous culture.

mycelial surface. Conidia were abundant. All cultures produced water-soluble pigments that diffused into the medium in advance of marginal mycelial growth. The perfect stage was not produced in culture.

Monosporous cultures were much the same in their general morphology, although there appeared to be some geographic relationship in cultural characteristics among isolates taken from specimens collected at specific localities. This phenomenon has been described by the writer (2).

Occasional cultures varied considerably in their general morphology and could easily be distinguished from the ordinary type of culture. Fan-shaped patches or sectors, which lacked pycnidia, characterized these cultures (Fig. 1 B). Mycelial subtransfers, made by cutting small bits of mycelium from the margins of sectors, were placed on flasks of potato-dextrose agar. Each subtransfer developed the characteristics of the variant from which it was taken. Variant subtransfers produced no pycnidia or conidia and could only be perpetuated by mycelial transfer. Morphologically distinct variants were often obtained from different monosporous cultures (Fig. 1 C). Variants remained stable through repeated subtransfer on potato-dextrose agar for over two years.

Variant cultures were nonpathogenic. As no spore form was produced by the variant cultures, mycelial mats were macerated and hypodermically injected into the leaf curls of known susceptible smooth brome plants but no infection was obtained. When plants were inoculated with a conidial suspension of *Selenophoma bromigena* by this method excellent infection resulted.

SUMMARY

Selenophoma bromigena causes a leaf spot on *Bromus inermis*. The disease is general in its distribution, appearing wherever smooth brome is grown. The fungus appears to be specific in attack, producing disease symptoms only on *B. inermis* of the many brome species. Other grasses and cultivated cereals were not infected in artificial inoculation trials. The disease is most prevalent during the spring and develops best in moist, cool weather. No perfect stage of the fungus has been found. The fungus apparently overwinters in the pycnidial stage. Penetration of the host tissues is direct. The fungus is disseminated by the wind and rain and by infected seed. Smooth brome plants resistant to the fungus are common, and selection and breeding present a desirable means of control. Specialized races of the fungus exist in nature, as two distinct parasitic races were isolated.

Monosporous isolates of *Selenophoma bromigena* grew best on potato-dextrose agar between 20° and 25° C. and were uniform in their cultural characteristics. Occasional cultures produced sectors or variants. Variants did not produce pycnidia or conidia and could only be perpetuated by mycelial subtransfers. Variants were stable in culture, remaining constant for two years through repeated subtransfer. Variant type cultures were nonpathogenic.

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THE BROWN LEAF SPOT ON BROMUS INERMIS CAUSED BY PYRENOPHORA BROMI[1]

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INTRODUCTION

A brown leaf spot was observed in the spring of 1941 on smooth bromegrass (*Bromus inermis* Leyss.) in the grass nurseries at the Wisconsin Agricultural Experiment Station at Madison. This paper presents a study of the life history of the causal organism, its relationship to the host and the factors influencing the development of the disease.

THE DISEASE

History

The causal organism was identified as *Pyrenophora bromi* (Died.) Drechsler (*Helminthosporium bromi* Died.). The first description of the disease is in Diedicke's (1) report from Germany in 1902. He described the fungus as a parasite on *Bromus asper* Murr., believing it to be a biological species of *Helminthosporium gramineum* Rab. Later (2) he recognized it as a distinct species, *H. bromi*, and also described the ascigerous stage as *Pleospora bromi* on the same host. Krieger[4] collected *H. bromi* on *Bromus inermis* Leyss.

Drechsler (3) contributed morphological details by which *Helminthosporium bromi* could be distinguished from *H. teres* Sacc., a distinction not previously made by Diedicke whose conidial measurements rendered the two species indistinguishable. Drechsler also transferred the ascigerous stage to the genus *Pyrenophora* Fr., which has bristles on the perithecium, distinguishing it from *Pleospora* Rab. which has a smooth perithecium. While the former genus has not been accepted universally, the distinction has been recognized as valid by Saccardo (6) and Lindau (4). Accordingly, the causal organism will be termed *Pyrenophora bromi* (Died.) Drechsler throughout this paper.

Symptoms

The symptoms of the disease are essentially those described by Diedicke and corroborated by Drechsler. Minute, dark brown, scattered specks appear on the young leaf blades. A yellow halo gradually develops around each spot. Both the central spot and the surrounding halo increase in size,

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[4] Krieger, W. Fungi Saxonici. No. 1941 *Helminthosporium bromi* Died. (Exsiccati). 1903, 1905.

especially longitudinally, and coalescing lesions frequently form large, yellowed patches on the leaf (Fig. 1, left). These symptoms are followed by a general yellowing of the leaf from the tip downward until the entire leaf withers. Conidiophores may be produced on or near the individual brown spots or generally over the surface of the withered leaf.

Although *Pyrenophora bromi* usually occurs alone on *Bromus inermis*, it is sometimes found with other pathogens.

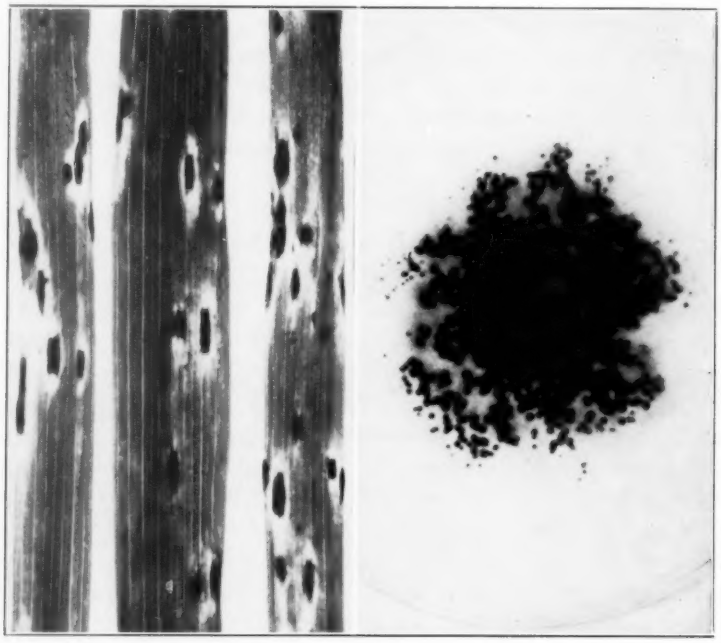

FIG. 1. *Pyrenophora bromi*. Left. Typical symptoms on *Bromus inermis*. Right. Perithecial initials produced on potato-dextrose agar, as seen from the under side of the Petri dish. Photographs by Eugene Herrling.

Description

The conidia produced by *Pyrenophora bromi* were described by Diedicke, whose description was later revised by Drechsler. In his original report from Germany, Diedicke stated that the conidia of the fungus measured 108–150 $\mu \times 13$–20 μ, with 4–6 septa. Working with material collected at Madison, Wisconsin, Drechsler was unable to substantiate these measurements. He found that conidia measured 45–265 $\mu \times 14$–26 μ, with 1–10 septa, and that the contour of the basal cell was hemiellipsoidal.

Conidial measurements made by the writers agreed substantially with those of Drechsler. Typical conidia from host plants in the field and from potato-dextrose-agar cultures varied from 57 to 201 μ in length, and from 13 to 19 μ in diameter. Under certain conditions, however, the fungus produced much larger conidia. When diseased leaves were removed from plants and maintained for 2 or 3 days in a Petri-dish moist chamber, conidia of atypical length, measuring as much as 400 μ, were produced.

According to Drechsler the mature perithecium is a dark brown subglobose body 0.3–0.4 mm. in diameter and embedded in the leaf tissue, and it has an irregular ostiolar beak which protrudes above the broken epidermis of the leaf. A variable number of septate, sterile bristles were observed near the tip of the ostiolar beak. The ascus was described as having a short stipe at the base and a characteristic ring-like thickening at the apex, with the light brown ascospores borne in distichous arrangement in the granular epiplasm. The ascospores, uniformly divided by 3 transverse septa, measured 20–30 μ × 45–72 μ.

Little could be added to this description except in the way of confirmation. Asci were from 190 to 300 μ long, and from 36 to 60 μ wide. Ascosporic measurements were 48–77 μ × 22–30 μ. The segments of the ascospore were commonly divided by one or two longitudinal septations, and a gelatinous matrix surrounded each spore after discharge from the ascus.

HOST RANGE OF THE PATHOGEN

Pyrenophora bromi has been reported as attacking only *Bromus inermis* in North America. Host range studies made during this investigation included 6 grasses and 4 cereals common to Wisconsin: quackgrass (*Agropyron repens* (L.) Beauv.), redtop (*Agrostis alba* L.), smooth bromegrass (*Bromus inermis* Leyss.), timothy (*Phleum pratense* L.), Canada bluegrass (*Poa compressa* L.), Kentucky bluegrass (*Poa pratensis* L.), barley (*Hordeum vulgare* L.), oats (*Avena sativa* L.), rye (*Secale cereale* L.), and wheat (*Triticum vulgare* Vill.). Tests were made in the greenhouse with seedling plants, each species receiving 4 inoculations with ascospores of *Pyrenophora bromi*. The plants were held in a moist chamber for 4 days, until *B. inermis* developed typical brown-spot lesions, and then were incubated for another 7 days on the greenhouse bench.

Only *Bromus inermis* developed typical brown-spot symptoms and produced lesions from which the fungus could be reisolated. Inbred lines of *Bromus inermis* differed in reaction to brown spot. Some lines were completely susceptible to the disease while others were highly resistant.

OVERWINTERING OF THE PATHOGEN

Perithecia appear to be the only means of overwintering the fungus in Wisconsin. These structures are abundant in the leaf tissue, becoming macroscopically visible as early as June 4 at Madison. Although perithecial development was studied continuously through the summer and fall, no asci were ever found delimited during the current season. The low temperatures of late fall and winter are necessary for maturation of the perithecia. During the subsequent spring mature asci can be found in the perithecia on overwintered leaf material lying on the ground.

In order to check these observations, dried leaves containing immature perithecia were collected and divided into 3 lots. One lot was kept dry at 20° C., the second was dry at 10° C., while the third was on moist filter

paper at 10° C. After 3 months, perithecia from all 3 lots were crushed and examined for ascospores. The importance of low temperature and moisture was emphasized by the results: ascospores were found only in the third lot, maintained at 10° C. and supplied with moisture.

Experiments were made to determine other possible means of overwintering the fungus. Heavily infected plants on which no perithecial initials had developed were removed from the nursery and potted early in November. These plants were allowed to freeze and were held out-of-doors throughout the winter. In early April, dried leaves were collected from them, surface-sterilized in a 1 to 10 solution of sodium hypochlorite for varying intervals, and plated on potato-dextrose agar to determine the possibility of mycelium overwintering in the leaf tissues. *Pyrenophora bromi* was never recovered in any of these platings. When the overwintered plants resumed growth in the spring, there was no evidence of disease on the new leaf blades.

Several lots of conidia on glass slides were held out-of-doors at 15–20° F. for 3 days. The slides were then moistened and incubated at 20° C., but none of the conidia germinated. Evidently the thin-walled conidia cannot survive the winter in Wisconsin.

LONGEVITY OF SPORES

In considering the importance of the ascigerous and the imperfect stages of the fungus, it seemed advisable to determine the comparative longevity of ascospores and conidia. Field collections of sporulating material were brought into the laboratory, and spore germination was tested each subsequent day. Conidia on dried leaves remained viable for a maximum of 11 days after storage in the laboratory. Conidia that were mounted in water on glass slides, allowed to dry, and stored in the laboratory remained viable for a maximum of 9 days. This experiment was repeated at various times with 6 different lots of spores.

Ascospores had greater longevity than conidia. Perithecia from overwintered leaves, after storage in the laboratory for 7 months, yielded viable ascospores. Crushed perithecia were mounted on glass slides and stored in a dry state to test the longevity of discharged ascospores. Although drying for more than 2 weeks resulted in reduced percentages of germination, 50 per cent of the spores germinated after 26 days, the longest period for which tests were made.

SPORE GERMINATION

Ascospores and conidia germinated over a wide temperature range, with the high and low levels being the same for each spore form. The optimum for each, however, differed by 8° C.

Ascospores and conidia in hanging drops of distilled water were placed in controlled temperature cabinets, set at 4-degree intervals, from 0° to 36° C. All mounts were observed every 2 hours for 20 hours. Neither spore form

germinated at 0° or 36° C. within 20 hours. The optimum temperature for ascospore germination, based on the number and length of germ tubes, was 20° C. and germination began within 2 hours. The optimum for conidia was 28° C. with germination beginning within 2 hours. Germination of both spore forms was equally good in light or darkness.

DISSEMINATION OF INOCULUM

Ascospores are discharged readily from the perithecium in the presence of moisture and may be further distributed by wind, as indicated by spore-trapping experiments. Glass slides, with approximately 9 sq. cm. of surface covered with a thin film of vaseline, were mounted in centers of infection at the level of developing brome blades (approximately 3–6 inches) during the last week in April and the first week in May, 1942. Slides were replaced and examined each day. Slides exposed for 24 hours following rainfall had from 7 to 10 ascospores per slide, while slides exposed 40 hours after rainfall had no spores.

Conidia apparently play a minor rôle in the spread of the disease during periods favorable for spore production. Conidial production at Madison is extremely sparse over the growing season of the host, occurring only during cool, wet periods. In spite of constant search for sporulating material during two years, the only conidia found in any abundance were collected during October, 1942. In the spore-trapping experiments, few conidia were caught; the maximum number ever obtained on a single slide was 3.

Since some members of the genus *Helminthosporium* are known to be seed-borne, this possibility was tested in the case of *Pyrenophora bromi*. Seeds were collected from the panicles of heavily infected plants and at one-month intervals for six months were plated on potato-dextrose agar. Although this experiment was repeated with 6 different lots of seeds, *P. bromi* was not recovered in any of the platings.

PATHOLOGICAL HISTOLOGY

In studies of fungus-host relationships, portions of the leaf were cleared for 48 hours in a mixture consisting of equal proportions of acetic acid and absolute alcohol. Cotton blue and lacto-phenol were satisfactory for staining and mounting these preparations and were especially good for demonstrating early stages of infection. In studying older lesions, well-pressed leaf specimens could be sectioned dry with the aid of a sharp razor blade and mounted directly in cotton blue diluted with lacto-phenol. The fungus in the host tissues stains a deep blue, while little if any of the stain is taken up by the leaf cells.

To determine the method of penetration, plants were sprayed with ascosporic inoculum and incubated in a moist chamber. Each day thereafter, leaves were removed from these plants, cleared, stained, and examined microscopically.

The organism enters the host by direct penetration of the epidermal cells.

The germ tube from the ascospore grows over the leaf surface and produces an appressorium at its tip. The infection peg penetrates the epidermal cell directly through the uninjured cuticle. No evidence of stomatal penetration was ever encountered, the germ tubes frequently passing over and beyond stomata to form appressoria elsewhere on the leaf surface.

After penetration, the fungus establishes itself in the intercellular spaces of the epidermal and mesophyll tissues and ramifies freely between the mesophyll cells. The epidermal cells collapse soon after invasion and within 3 days the mesophyll cells collapse and turn brown. At this time the lesion is macroscopically visible as a small brown spot surrounded by a water-soaked area. The progress of the fungus is somewhat limited by the vascular bundles, accounting for the elongate contour which is typical of most well-developed lesions. Browning and collapse of the cells progress from the upper to the lower leaf-epidermis so that the lesion is visible from beneath the leaf 4 days after inoculation. Conidiophores emerge singly or in pairs between the upper epidermal cells, usually after the leaf has withered.

Perithecia are formed in the mesophyll, the leaf tissues becoming distended as the initials are formed. Further growth of the perithecium ruptures the leaf epidermis, exposing the beak.

FACTORS AFFECTING DISEASE DEVELOPMENT

Like most of the leaf-spot diseases of smooth bromegrass, brown spot is favored by cool weather and abundant moisture. Its most destructive phase appears during the spring and reaches a peak about the first of June in Wisconsin. Through the hot, dry portion of the summer there is relatively little, if any, spread of the disease. Rain is necessary for ascosporic discharge and spore germination. Cloudy periods lasting for several days, with intermittent rainfall, are especially conducive to new outbreaks of infection.

These observations were corroborated by controlled experiments performed in the greenhouse. Inoculated plants growing in pots were held under moist-chambers for 3 days at 4°, 16°, 20°, 24°, and 28° C. Duplicate lots of plants for each treatment were used in 4 different trials. Three days after inoculation the moist chambers were removed and the lesions allowed to develop for another three days. On the basis of the number of lesions formed and the size of individual lesions, the disease always developed best between 16° and 20° C. No lesions developed at 4° C. Moisture, either in the form of a continuous film or a high air humidity, was necessary because in parallel experiments without moist-chamber treatment or a film of water after inoculation no infection occurred.

LIFE HISTORY OF THE ORGANISM IN RELATION TO DISEASE DEVELOPMENT

From the standpoint of disease development, the asciferous stage is the most important one in the life history of *Pyrenophora bromi*. Ascospores can be found very early in the spring in overwintered perithecia, formed during the previous year. Such perithecia provide the abundant initial

inoculum and also remain as potential sources of inoculum throughout the spring.

Conidia are borne on the initial lesions or, more frequently, on the discolored tips of infected leaves during periods of cool weather and high humidity. Although they cause some infections, conidia are produced so infrequently and in such sparse quantities that they are of less importance in the disease cycle than ascospores. The conidia are short-lived and do not survive the winter in Wisconsin.

Perithecia are formed in the leaves during the summer but do not produce mature ascospores until the following spring. Thus *Pyrenophora bromi* requires one year to complete its life cycle.

CULTURAL STUDIES

Growth of the fungus was slow on all artificial media. A number of media were tried, but none was superior to potato-dextrose agar composed of 200 grams of peeled potatoes, 25 grams of agar, and 20 grams of dextrose per liter of distilled water.

According to Drechsler, cultures derived from conidia differed in no way from those derived from ascospores, and the appearance of black sclerotial bodies within 12 days characterized the growth of the fungus on agar. Repeated monosporous cultures of both conidia and ascospores made during this investigation verified these statements. The black sclerotial bodies, actually perithecial initials, become visible on the underside of the culture within 8–9 days after isolation (Fig. 1, right).

On potato-dextrose agar the fungus is at first white and fuzzy, later becoming gray to buff. The aerial growth is short. A culture 20–30 days old usually appears as a rough disc, with a raised periphery and a somewhat sunken central portion, covering approximately three-quarters of a Petri dish. The fungus appears to be stable on potato-dextrose agar, since no sectoring was observed.

In an effort to induce the production of conidia, always extremely sparse on agar, cultures of *Pyrenophora bromi* growing on potato-dextrose agar were exposed to continuous fluorescent light for 5–7 days. Some increase in sporulation was noted, and cultivation of the fungus on vegetable agar (5) accomplished the same result, although neither of these treatments resulted in what might be termed abundant conidial production as judged by any fungus that sporulates well in culture.

Since there is no record of the production of the ascigerous stage of *Pyrenophora bromi* on artificial media, various treatments were applied to cultures in an attempt to bring the perithecia to maturity. Subjecting cultures 3 to 4 weeks old to low temperatures for 3 months resulted in the production of mature ascospores which readily produced the characteristic disease symptoms when transferred to susceptible plants. As a control, several cultures were kept at laboratory temperature but no ascospores were produced.

Perithecia formed in culture do not discharge their contents readily. The asci, being tough and elastic, are very difficult to rupture. Ascospores germinate readily within the ascus, however, and produce infection on susceptible plants. Asci and ascospores produced in culture differ in no respect from those formed in nature on leaf-tissue, except that the spores formed in culture are at times almost hyaline. The perithecia on potato-dextrose agar are not always similar in shape to those on the host leaf, but the production of bristles on the perithecium is consistent. Not all asci within a single perithecium mature at the same time, and all stages of development, from asci with spores undelimited to those containing 8 mature spores, may be found.

In order to determine the range of temperatures at which asci mature, cultures that had been grown for 3 weeks at laboratory temperature were incubated at 4°, 8°, 10°, 12°, and 20° C. for 3 months. No ascospores were produced at temperatures above 12° C.

Pyrenophora bromi is homothallic, since perithecia bearing mature asci and ascospores were produced in single-ascospore cultures.

SUMMARY

The causal organism of the brown leaf spot on *Bromus inermis* was identified as *Pyrenophora bromi*. Host range studies demonstrated that the fungus is specific to *B. inermis*. There are indications of differences in disease reaction among inbred lines of *B. inermis* in Wisconsin.

Pyrenophora bromi overwinters in the perithecial stage. Ascospores are the important inoculum; conidia are fragile, sparsely produced, and short-lived. Both spore forms germinated at temperatures ranging from 4° to 32° C., the optimum for ascospore germination being 20° C. and that for conidia 28° C.

The fungus is homothallic. The ascigerous stage was produced repeatedly by subjecting mono-ascosporic cultures to low temperatures for 3 months.

Pyrenophora bromi invades the host by direct penetration of the leaf epidermis and ramifies intercellularly in the leaf tissues. The development of the disease is favored by cool weather and abundant moisture.

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ALTERNARIA RICINI (YOSHII) HANSFORD, THE CAUSE OF A SERIOUS DISEASE OF THE CASTOR-BEAN PLANT (RICINUS COMMUNIS L.) IN THE UNITED STATES

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(Accepted for publication November 20, 1944)

INTRODUCTION

Castor oil is used in the production of paints, varnishes, textiles, leather, hydraulic fluids, soap, medicine, linoleum, printing ink, lubricants, and many miscellaneous products.

With the entrance of the United States into World War II, imports of castor beans and oil were seriously curtailed, while at the same time demand for these materials increased. Domestic production of castor beans was immediately contemplated but no quantity of reliable seed-stocks was available, consequently variety tests and seed-increase programs were begun by the United States Department of Agriculture.

In the course of a variety and adaptation test at the Plant Industry Station, Beltsville, Maryland, in 1942, a fungus of the genus *Alternaria* was found fruiting extensively on ripe capsules of the castor-bean plant. Since the racemes were mature when this fungus was first noted, the organism was thought to be a saprophyte or an extremely weak parasite. However, during the seasons of 1943 and 1944 the same fungus caused serious damage to the seedlings, inflorescences, and leaves of the castor-bean plant.

Other workers have previously encountered species of *Alternaria* and *Macrosporium* on the castor-bean plant. Cooke (5) described *M. compactum* on mature stems of plants in Texas. Dastur (6) and Chibber (4) observed an Alternaria leaf spot in India. Parisi (12) described *M. cavarae* causing a leaf spot and seedling disease in Italy. Tropova (13) reported *M. cavarae* on the leaves, *M. nigricans* Atk.[2] on the racemes and *A. tenuis* Nees on the stems of plants in Russia. Tropova (14) again reported *M. cavarae* on the leaves in Russia; Kvashnina (9) reported *M. cavarae* on the cotyledons, leaves, and racemes in Russia. Yoshii (16) described a leaf spot in Korea and Japan and demonstrated by inoculation experiments that the causal organism was a species of *Macrosporium* which he named *M. ricini*. Baldacci (2) isolated *M. cavarae* from seed apexes in Italy and attributed leaf-spotting to this organism. Golovin (7) reported *M. cavarae* on the leaves, racemes, and capsules and *A. tenuis* on the stems of castor-bean plants in Russia. Bitancourt (3) found species of *Alternaria* causing leaf spots in Brazil. Weiss (15) reported species of *Alternaria*

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[2] The binomial as given by Atkinson is *M. nigricantium*.

associated with leaf spots in Florida, Louisiana, and Texas, and *A. brassicae* (Berk.) Sacc. causing a leaf spot in New York. McClellan (10) reported *A. compacta* (Cke.) McClellan attacking castor-bean seedlings in the greenhouse. Hansford (8) changed the designation of *Macrosporium ricini* to *Alternaria ricini*.

SYMPTOMATOLOGY

Seedlings. The condition of Alternaria-diseased seedlings can be best described as a die-back or blight. The cotyledons are stunted, spotted, and malformed. If the infection is extensive, the seedling dies but if only the

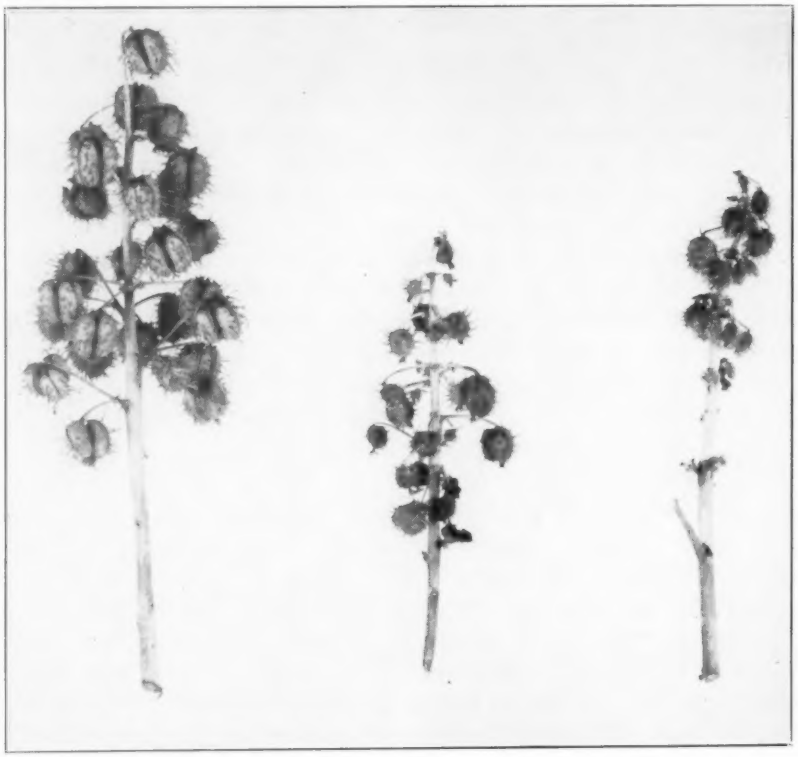

FIG. 1. *Alternaria ricini* on the racemes of *Ricinus communis* (variety U. S. No. 4). Left to right, normal raceme, partially affected raceme, and heavily affected raceme.

tips of the cotyledons are affected the seedling survives but its growth is retarded. Often the spores of the causal organism can be found on the surface of injured cotyledons.

Inflorescences. The first infections of the inflorescences seem to be confined to capsules which have attained half or more of their ultimate size. Two types of symptoms can be found. In the first the capsules wilt suddenly, turn purple or dark brown (depending on the host variety), the pedicels collapse, the seed is usually poorly filled, and normal dehiscence fails to take place (Fig. 1). In the second type of infection a sunken area

develops on one side of the capsule and this area enlarges until the whole capsule becomes involved. In this case poorly-filled seed is not prevalent and no great interference with dehiscence occurs. As the disease spreads and large quantities of inoculum are produced, inflorescences in any stage of development are attacked. In heavily infected areas all of the young racemes and even flower primordia are killed. Following periods of high humidity the fungus fruits extensively on the surface of infected inflorescences, giving them a black, sooty appearance (Fig. 2). When the first harvest was made at Beltsville, Maryland, on September 6, 1943, the spores

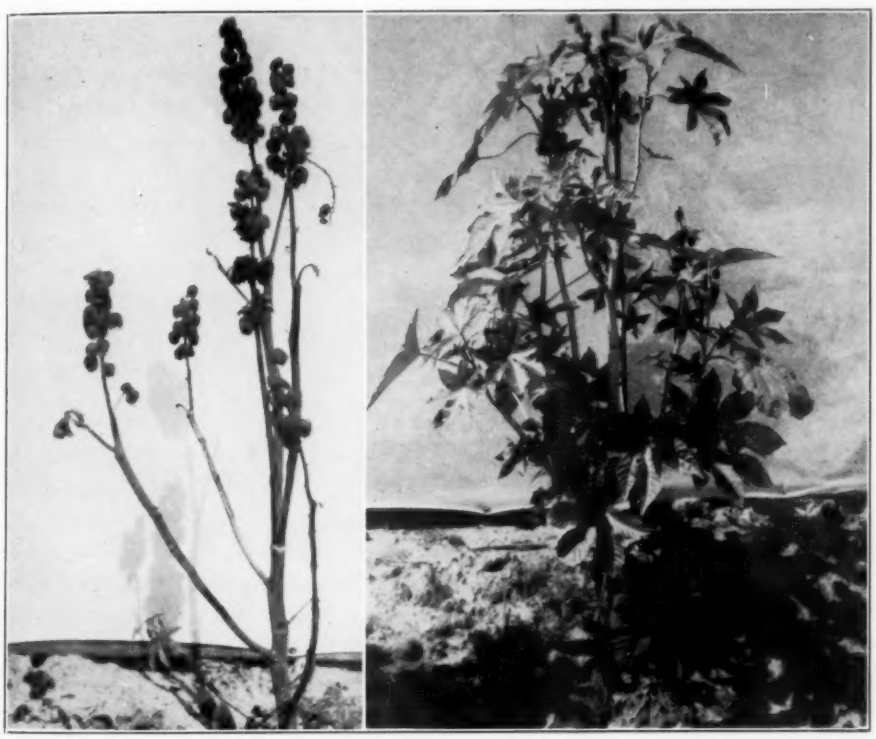

FIG. 2. Left, defoliation of a selection of *Ricinus communis* following severe leaf infection by *Alternaria ricini*. Right, an adjacent selection of *R. communis* with leaves only slightly affected. Note the blackening of capsules of both plants caused by the presence of mycelium and spores of *A. ricini*.

of *Alternaria* rose in clouds of dust from the capsules, and workers' hands became black with spores. The number of plants visibly affected by September 15 was determined on an area of approximately five-sixths of an acre. Of a total of 3,603 plants, 70 per cent were affected to some degree.

Leaves. A certain amount of leaf spotting and premature defoliation was noted throughout the season. As the raceme infection spread this leaf spotting and defoliation became increasingly severe. By August 31, 1943, some selections were almost completely defoliated while others were little affected (Fig. 2). Diseased leaves dry and curl at the edges and scattered

brown spots, which often coalesce, appear over the surface. When sufficient humidity is present the fungus fruits extensively over the infected portion of the leaf. When a large area of the leaf becomes involved, abscission follows.

THE CAUSAL ORGANISM

Morphology. Material for determining the spore characters and dimensions of the causal organism was collected immediately following periods of high humidity from naturally infected field-grown capsules on which the sporulation was fresh. The conidia and conidiophores were mounted in lactophenol, measurements being made with an ocular micrometer. Only mature spores were measured.

The description of the organism is as follows: Conidiophores solitary or in fascicles, simple or branched, olivaceous in plain water and lactophenol,

FIG. 3. Conidia of *Alternaria ricini* (Yoshii) Hansford, scraped from the surface of an infected castor-bean capsule. (× 80.)

becoming yellow-green after a short time in lactophenol, length 70–128 μ, diameter 4–6 μ, with 5–10 septa; conidia obclavate, dark olive-green en masse and light-olive when viewed singly in either water or lactophenol (if stored in lactophenol the conidia become cinnamon-brown en masse and straw-colored when viewed individually). The conidia exclusive of the beak are 47–96 μ long, with a mean of 70 μ, and 15–29 μ wide, with a mean of 22 μ. There are 5–12 transverse septa, with a mean of 8, and 0–2 longitudinal septa, with a mean of 1.6. The conidia have hyaline beaks which are 51–200 μ long, with a mean of 112 μ. Branching of the beak was observed in only one case. Typical conidia are shown in figure 3.

TAXONOMY

The differentiating characters of the fungus were compared with the other species of *Macrosporium* and *Alternaria* reported as occurring on the castor bean. This fungus differs from *M. compactum* Cke. (*A. compacta* (Cke.) McClellan) and *M. cavarae* Parisi in that the conidia have long beaks

and are considerably larger than those of the latter two species. *M. cavarae*, as described by Tropova (13, 14), Kvashnina (9), and Golovin (7), agrees well with the *Alternaria* found by the writer but fails to fit Parisi's original description of *M. cavarae*. *M. nigricans* (*M. nigricantium* Atk.) and *A. tenuis* Nees as described and illustrated by Tropova (13) are much like the *Alternaria* under discussion but these descriptions also fail to agree with the original descriptions of these species as given by Atkinson (1) and Nees (11) respectively. *A. tenuis* as reported by Golovin differs both from the *Alternaria* of the writer and the description of *A. tenuis* as given by Nees (11). *M. ricini* (*A. ricini* (Yoshii) Hansford) as described and illustrated by Yoshii (16) appears to be the same fungus as that reported herein. The conidia as described by Yoshii tend to be slightly shorter than in the species under study but this variation is thought not to be sufficient to justify giving this fungus a new specific designation. Considering the extreme variability within any one species of the genus *Alternaria*, it is conceivable that the same fungus might have been the cause of the disease in several and perhaps all of the instances reported in the literature, but the material is not available and it is not within the scope of this article to attempt to reduce these species to synonymy. However, because of the ambiguity in the use of the binomials suggested prior to Yoshii's work, they may be disregarded in the present study and the binomial *A. ricini* (Yoshii) Hansford accepted for the fungus herein described.

EXPERIMENTAL TESTS

In addition to the large numbers of spores of *Alternaria ricini* observed on infected capsules and leaves, repeated isolations from affected organs consistently yielded this fungus.

Reliable artificial infections of capsules were obtained only by wounding the surface of each capsule with a sterile needle and introducing the Alternaria spores and mycelium into the wound. The symptoms produced on inoculated capsules were identical with those observed as a result of natural infections. The causal organism was re-isolated readily from the seed coat, the central column of the capsule, and other capsular material. The results of typical inoculations are summarized in table 1. On controls treated in a like manner with the absence of the causal organism no symptoms developed and capsules ripened normally.

Castor-bean plants for leaf inoculations were grown in 5-inch pots in the greenhouse or in soil on a greenhouse bench. Plants were inoculated when in the sixth true leaf stage. Suspensions of spores and mycelium were made by dispersing the fungal mat of single-spore cultures in sterile water using a Waring Blendor. The plants were atomized with this suspension and placed in a moist chamber or covered with a large bell jar. In this humid atmosphere symptoms were visible in two days. The plants were removed from these moist conditions after 2 to 4 days but the fungus, once established, continued to attack the leaves, petioles, and leaf scars, causing the

leaves to abscise prematurely. Control plants, sprayed with water only, showed no symptoms. An inoculated leaf is shown in figure 4. The fungus was recovered readily from inoculated leaves and typical spores were produced on these leaves in the greenhouse, when the humidity was maintained at a high level. Results of leaf inoculations are shown in table 1.

Seed from heavily infected capsules nearly always carries the fungus either on the seed coat, caruncle, or endosperm. In order to determine the subsequent effect of this seed-borne fungus on the seedlings, seed from infected capsules of the varieties, Conner and Doughty 11, was planted in sterilized soil in the greenhouse. After emergence the plants were examined for lesions and malformations. Seventy-two per cent of the seedlings of the Conner variety and 17 per cent of the variety Doughty 11 had symptoms

FIG. 4. Right, leaf of *Ricinus communis* (variety Kentucky 38) following inoculation with *Alternaria ricini*. Left, a normal leaf.

typical for *Alternaria ricini*. One hundred of these seedlings with stem lesions were taken at random and the diseased portions plated on acid potato-dextrose agar. *A. ricini* was readily recovered from these diseased seedlings but the extreme lack of fruiting of this fungus under most cultural conditions made it impossible to check the spore size and type from agar plates. Therefore, 100 diseased seedlings were washed thoroughly in tap water and placed in moist chambers. After 3 to 5 days the lesions were examined for spores. Mycelium, but no spores, was found on 25 seedlings. Fusarium spores were found on 23 seedlings, and *A. ricini* spores of the type produced on naturally infected capsules and leaves in the field were found on 52 seedlings.

DISTRIBUTION OF THE DISEASE

Isolates of *Alternaria*, having the cultural characteristics of *A. ricini*, were obtained by the writer from 32 of 34 samples of castor-bean seed from

TABLE 1.—*Infection of capsules and leaves of the castor-bean plant following inoculation with Alternaria ricini*

Plant number[a] and part inoculated	No. capsules or leaves inoculated	No. infected		
		Heavily	Moderately	Lightly
Capsules—field				
44–1	10	9	0	1
44–2	10	9	0	1
44–3	8	5	3	0
44–4	12	11	1	0
44–5	13	4	9	0
44–6	9	6	3	0
44–7	11	0	9	2
44–8	18	13	5	0
44–9	20	14	6	0
44–10	15	0	0	15
Check–1	13	0	0	0
Check–2	10	0	0	0
Check–3	17	0	0	0
Check–4	12	0	0	0
Check–5	15	0	0	0
Capsules—greenhouse				
45–1	15	15	0	0
46–1	10	8	0	0
46–2	4	4	0	0
46–3	4	2	0	0
46–4	6	6	0	0
Check–6	15	0	0	0
Check–7	18	0	0	0
Leaves—greenhouse				
47–1	5	3	1	1
47–2	5	3	0	2
47–3	5	3	1	1
47–4	5	3	1	1
47–5	5	5	0	0
47–6	6	4	1	1
47–7	4	2	0	2
Check–8	5	0	0	0
Check–9	5	0	0	0
Check–10	5	0	0	0
Check–11	5	0	0	0

[a] All plants were of the variety, Kentucky 38, except plants 46–1, 2, 3, 4, Check–6, and Check–7, which were variety number 227, a spineless variant of variety U. S. 4.

the 1942 crop, representing 34 different locations in the United States. That *A. ricini* was widespread on the castor-bean plant in the United States in 1943 is evidenced by the fact that spores of *A. ricini* were abundant on the surface of capsules from Texas, Louisiana, Mississippi, Georgia, South Carolina, three counties in Tennessee, four counties in Kentucky, and two counties in Arkansas.

DISCUSSION

Alternaria ricini is capable of infecting the seedlings, leaves, capsules, and seed of the castor-bean. Seedling infections lead to reduced stand and vigor, leaf infections cause reduced leaf area, and capsule and seed infections result in reduced yields and provide a means of spread and overwintering for the fungus. If it ever becomes necessary for the United States to go

into large-scale production of castor beans, the Alternaria disease of the castor-bean plant may well become an extremely important economic factor. No means of control have been developed, but preliminary tests indicate that the seedling phase of the disease may be controlled to some extent by seed treatment. A search is being made for disease-resistant material, although no selections have been found to date which seem to have any appreciable resistance.

SUMMARY

A disease of the castor-bean plant in the United States is described and the causal organism was determined to be *Alternaria ricini* (Yoshii) Hansford. The taxonomy of the fungus is discussed. The pathogen causes a seedling disease, leaf spot, and a raceme disease. The fungus is seed-borne and has been identified on castor-bean capsules from Texas, Louisiana, Mississippi, Georgia, South Carolina, Tennessee, Kentucky, and Arkansas. No means of control have been developed but there seems to be some promise for seed treatment in controlling the seedling phase of the disease.

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PATHOGENICITY OF THE DUTCH ELM DISEASE FUNGUS

L. J. Tyler and K. G. Parker[1]

(Accepted for publication December 4, 1944)

Swingle[2] first reported that monoconidial and monoascosporic progenies of *Ceratostomella ulmi* (Schwarz) Buisman differed widely in cultural characters when grown on nutrient agar. An intensive study by Walter,[3] of variants that originated as sectors in mass isolates from diseased elms and as sectors in monoconidial progenies, revealed the existence of numerous cultural races in the same fungus. He ascribed the development of these cultural races to mutation. Since *C. ulmi* is normally heterothallic,[2, 4] Walter emphasized that such races might arise also through the sexual process. Observations by the present writers over a period of 8 years on cultures of monoconidial progenies from sector variants that appeared in mass isolates of *C. ulmi* generally confirm those of Walter.

The existence of races, within the species *Ceratostomella ulmi*, that differ in cultural characters suggested that they might differ also in pathogenicity to the elm. In 1932, Buisman[5] stated that lines of *C. ulmi* differ in virulence but the extent and constancy of these differences was not revealed. This paper is to present some data concerning significant differences noted in the capacity of different races to produce disease and data which further show that each race was constant in this character.

MATERIALS AND METHODS

Fungus. Eight cultural races of *Ceratostomella ulmi* were used; they originated from diseased elm tissue collected in the summer and fall of 1934. Races A1, A2, A3, and A4 each arose as a sector variant in a culture of *C. ulmi* obtained from diseased tissue taken from a tree at Elmsford, New York. Races B, C, D, and E orginated similarly but from different diseased trees; the latter trees were in Bronx borough of New York City. Stock cultures of the different races were started, during the winter of 1935, from single spores except for race E. This last race was entirely mycelial in type of growth and did not sporulate, so the stock culture was started from a single hypha. In addition to studying the pathogenicity of each race separately, seven of them were combined and used as a "mixture." Stock cultures of the different races were maintained on potato-dextrose agar and kept at ordi-

[1] The use of laboratory facilities and field space made available by the Boyce Thompson Institute for Plant Research, Yonkers, New York, is gratefully acknowledged.

[2] Swingle, R. U. A preliminary note on sexuality in the fungus *Ceratostomella ulmi*. Phytopath. 26: 925–927. 1936.

[3] Walter, J. M. Variation in mass isolates and monoconidium progenies of *Ceratostomella ulmi*. Jour. Agr. Res. [U. S.] 54: 509–523. 1937.

[4] Buisman, Christine. *Ceratostomella ulmi*, de geschlachtelijke vorm van *Graphium ulmi*, Schwarz. Tijdschr. Plantenz. 38: 1–5. 1932.

[5] Buisman, Christine. Verslag van de phytopathologische onderzoekingen over de iepenziekte, verricht in het Laboratorium, Willie Commelin Scholten, gedurende 1931. Tijdschr. Plantenz. 38: 17–36. 1932.

nary room temperature until the end of the year 1940. Afterward they were stored at about 5° C.

Inoculum was developed by growing the fungus in Petri dishes on sterile, cellulose, beer-glass coasters soaked with potato-dextrose solution. Spores formed on this medium were readied for use as inoculum by suspending them in sterilized distilled water. The density of the spore suspension of each race was adjusted to about ¼ million spores per ml. Since race E did not sporulate, the mycelium was used as inoculum without suspending it in water.

Trees. American elms (*Ulmus americana* L.) were grown from cuttings obtained from a single source and rooted during June, 1938. In April, 1940, the young trees were transplanted to the field. The planting of elms comprised 22 rows of 12 trees each and was located on a valley bottom in the Boyce Thompson Research Institute Arboretum at Yonkers, New York. At the time of inoculation the trees were in their 5th year of growth and from 6 to 9 feet high. There was considerable variation in vigor but this was offset by randomization; all trees were in an active stage of shoot elongation when they were inoculated.

Inoculation. The inoculum was introduced into the trees with a 10-ml. hypodermic syringe equipped with a 11/16-inch, No. LN special Becton-Dickinson & Co. needle which has the delivery aperture on its side near the point. After loading the syringe with the spore suspension the needle was inserted underneath the bark, on a tangent with the trunk circumference, at one point on each of two sides but at slightly different levels and about 2 feet above the soil line. As the needle was forced underneath the bark care was taken to injure some peripheral wood vessels to assure ingress. Three ml. of inoculum were delivered at each point. Since race E did not produce spores, bits of mycelium were introduced into small longitudinal trunk incisions that extended into the outermost vessels; after the inoculum was introduced into the wound the latter was covered with waterproof tape. The work of inoculating the trees was completed within 3 hours on June 19, 1942.

Eleven trees were utilized for each of the cultural races A2, A3, A4, B, C, D, and E, while for race A1 and for the "mixture" the number was twenty-two. Trees inoculated with a given race occurred only once within a row, and the different races were well randomized with respect to each other.

Recording data. The approximate percentage of foliage wilted per tree was estimated at intervals of 11, 20, 34, and 73 days following inoculation. The amount of dead wood per tree was accurately determined on October 21–22, 1942, in the following manner: the length of the trunk and of all branches of each tree up to the end of the 1941 growth was measured, then the linear inches of dead wood were obtained by measuring downward from the point at which 1941 growth had ceased. The significance of the differences between the mean amounts of dead wood per tree caused by the different races was analyzed statistically.

In May, 1943, the number of trees killed by the different races was recorded and the trees were cut and examined for discoloration. All of the cultural races used for inoculative purposes were recovered by making tissue cultures.

RESULTS AND DISCUSSION

Examination of the means for dead wood (Table 1) shows that cultural races A3, A4, and C are significantly weaker pathogens than the others. Furthermore, race A4 is less virulent than A3 and both are significantly less pathogenic than A1 and A2. It is recalled that races A1, A2, A3, and A4 originated more or less simultaneously as sector variants in a culture

TABLE 1.—*Pathogenicity of different cultural races of Ceratostomella ulmi to the American elm*

Cultural race	Index of wilt,[a] days after inoculation				No. trees killed[b]	Mean per cent of dead wood per tree[c]
	11	20	34	73		
A1	73	88	95	97	22/18	93.0
A2	74	93	92	89	11/5	86.2
A3	7	45	49	50	11/0	43.6*
A4	0	26	35	26	11/0	22.8*
B	64	94	91	89	11/6	83.0
C	0	36	51	46	11/0	34.2*
D	56	85	88	93	11/9	89.2
E[d]	0	0	0	0	11/0	None
Mixture	67	91	91	92	22/14	91.2

[a] Total possible wilt = 100.

[b] Numerator = number of trees inoculated; denominator = number killed.

[c] M.S.D. at 5 pct. point: 18.2 between groups with 11 trees each, 12.9 between groups with 22 trees each, 15.8 between groups with 11 trees and those with 22. Mean numbers with an asterisk are significantly different from others.

[d] Data were not used in the statistical analysis.

obtained from one diseased elm. Since A3 and A4 were less pathogenic than A1 and A2 it is evident that some loss in pathogenicity accompanied the appearance of sector variants from which the former 2 races originated. It is assumed that A1 and A2 were like the parent culture which must have been strongly pathogenic since the tree from which it was obtained died rapidly. The nonsporulating race E proved to be nonpathogenic; this organism never spread (as shown by discoloration in the elm tissue) more than 2 to 6 inches away from the inoculation points. This is a striking contrast to the invasiveness of the others. The strongly pathogenic races (A1, A2, B, and D) produced heavy discoloration of the tissue throughout the 1942 annual ring of the branches and trunks, while that caused by the moderately pathogenic races (A3, A4, and C) was equally intense but not so uniformly and widely distributed. The downward spread of the weaker races in the trunks was definitely limited and this was correlated with a general absence of dead wood in the trunks. The composite culture listed as "mixture" was equally as virulent as the most strongly pathogenic races and so it appears that the association of the weaker races with the stronger exerted no inhibitive effect upon the invasive activities of the latter.

The data concerning wilt and actual number of trees killed by the different cultural races (Table 1) are self-explanatory. These data further help to emphasize the marked differences in pathogenicity between some of the races.

The pathogenic behavior of the cultural races studied suggests that within the species *Ceratostomella ulmi* there exist a number of entities which possess unequal ability to produce disease. Some of these entities are strongly pathogenic, others moderately so, and still others are practically nonpathogenic. On this basis cultural races A1, A2, B, and D are strong pathogens, races A3, A4, and C are moderately strong, and race E is nonpathogenic.

Since cultural race E is a nonsporulating organism and is practically nonpathogenic it would be difficult to prove even by attempting to mate it with known male and female strains of *Ceratostomella ulmi* that it belongs to this species. However, it arose as a distinct sector variant in a culture of a typical mass isolate, and the isolate was obtained from discolored wood of an elm destructively affected by *C. ulmi*. Except for lack of sporulating structures this race looks much like other pathogenic ones when grown on nutrient agar.

The constancy of pathogenicity in the different races studied is attested to by some results obtained during the early spring and summer of 1935, seven years earlier. At that time potted elms were inoculated with all these cultural races, except A3. With allowances for the fact that but 2 to 3 trees were inoculated with a given race at that time, the results show that the pathogenicity of each race on the earlier date was essentially similar to that several years later. Races A1, A2, B, and D were strongly pathogenic, A4 and C were moderately strong, and race E was nonpathogenic. The fact that the pathogenic capabilities of the different races remained rather constant is striking and more so since all the races were continuously maintained on nutrient agar in test tubes during the 7-year period between the two tests. Race A1, only, had been passed through the elm in the interim.

Concluding, it appears that races unequal in pathogenic capabilities arose as sector variants in mass isolates of *Ceratostomella ulmi*. While these sector variants may have originated as a result of mutation, the manner of their origin needs further study.

Apart from the importance that such variants play in the diagnosis of specimens from suspected cases of Dutch elm disease,[5] these pathogenically distinct entities might have some influence on the production of disease epiphytotics. Furthermore, this racial specialization should be considered in a disease control program involving the development of disease resistant elms.

SUMMARY

1. Culturally distinct races of *Ceratostomella ulmi* originated as sector variants in mass isolates obtained from native diseased American elm.

[5] See footnote 3.

2. These cultural races were of unequal pathogenicity. Some of them were strongly pathogenic, others were moderately strong, and one was practically nonpathogenic.

3. The cultivation of these races on nutrient agar for 7 years, without passing them through the elm, did not appreciably change their pathogenicity.

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REPORT OF THE 36TH ANNUAL MEETING AND WAR CONFERENCE OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The 36th annual meeting and war conference of The American Phytopathological Society was held at the Netherland Plaza, Cincinnati, Ohio, December 9–11, 1944. Eighty papers on original research were accepted by the editorial committee for presentation at the meeting. Approximately 300 members attended. Twenty-three papers accepted were concerned with "fungicides." Sixteen papers were placed in the section on "virus and bacterial diseases"; a section on "disease resistance" included seven papers; while six papers were included in the section entitled "seed and soil treatments." Fourteen papers dealt with "various factors affecting disease development," and fourteen papers were in the section entitled "fungus diseases."

Conferences held were characterized by open and frank discussion of the problems considered. These conferences included "New developments in fungicides," "Future of plant disease surveys," "Seed treatments," "Breeding for plant disease resistance," "Activities of the war committee," and "Phloem necrosis of elms."

The Phytopathologists' dinner was held Sunday evening, December 10.

Reports indicated that the 1944 annual meeting and war conference afforded an excellent opportunity for members to discuss mutual problems. It also afforded an opportunity for members to exchange viewpoints and ideas that should be helpful in continuing and expanding research, teaching, and extension in Plant Pathology.

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Donations and Legacies. H. E. NEWHALL, R. E. VAUGHN, G. F. WEBER, S. N. ZELLER, N. J. GIDDINGS, Chm.
Extension Committee. O. C. BOYD, O. D. BURKE, H. P. GARRISS, R. J. HASKELL, J. O. MILLER, C. E. SCOTT, C. C. ALLISON, Chm.
Investments. MARVIN E. FOWLER, L. M. HUTCHINS, J. W. ROBERTS, R. M. CALDWELL, Chm.
Necrology. M. B. WAITE, A. G. JOHNSON, Chm.
Phytopathological Classics. L. C. KNORR, Editor and Acting Manager.
Placement. S. J. P. CHILTON, D. G. FLETCHER, M. W. GARDNER, R. J. HASKELL, L. M. MASSEY, R. S. KIRBY, Chm.
Public Relations. O. D. BURKE, C. J. EIDE, D. G. FLETCHER, F. J. GREANEY, L. S. HITCHNER, J. H. JENSEN, C. L. LEFEBVRE, E. W. LYLE, J. D. MOORE, A. G. NEWHALL, HARRY R. O'BRIEN, P. P. PIRONE, JOSÉ RODRIQUEZ, R. U. SWINGLE, H. W. THURSTON, J. C. WALKER, K. STARR CHESTER, Chm.
Regulatory Work and Foreign Plant Disease. C. R. ORTON, R. P. WHITE, E. C. STAKMAN, Chm.
Society Organization. GEORGE ARMSTRONG, O. C. BOYD, F. J. GREANEY, J. B. KENDRICK, J. C. WALKER, FREEMAN WEISS, Chm.

Union of American Biological Societies (and Biological Abstracts). DONALD FOLSOM, L. M. MASSEY, W. C. SNYDER, W. G. STOVER, F. V. RAND, Chm.; HELEN HART and E. M. JOHNSON (ex officio).

Special Committees:

Coordination in Cereal and Vegetable Seed Treatment Research. C. H. ARNDT, F. J. GREANEY, C. M. HAENSELER, K. W. KREITLOW, L. D. LEACH, R. W. LEUKEL, J. H. MCLAUGHLIN, GEORGE SEMENIUK, M. B. MOORE, Chm.

Fungus Nomenclature. C. M. TUCKER, D. S. WELCH, ERDMAN WEST, G. L. ZUNDEL, J. A. STEVENSON, Chm.

Nomenclature and Classification of Plant Viruses. C. W. BENNETT, L. M. BLACK, JAMES JOHNSON, H. H. MCKINNEY, FRANK MCWHORTER, H. EARL THOMAS, FREEMAN WEISS, Chm.

Plant Disease Prevention. J. F. ADAMS, K. D. BUTLER, C. E. F. GUTERMAN, E. C. STAKMAN, R. P. WHITE, C. G. WOODBURY, DONALD FLETCHER, Chm.

Publication Problems. M. W. GARDNER, FRANCIS O. HOLMES, A. J. RIKER, Chm.; R. M. CALDWELL and HELEN HART (ex officio).

Reorganization of International Cooperation. H. P. BARSS, G. H. COONS, J. G. HARRAR, OTTO REINKING, J. A. STEVENSON, E. C. STAKMAN, Chm.

Standardization of Fungicidal Tests. M. C. GOLDSWORTHY, C. S. HOLTON, J. G. HORSFALL, M. B. MOORE, C. F. TAYLOR, H. W. THURSTON, J. D. WILSON, S. E. A. MCCALLAN, Chm.

Terminology (Nomenclature) of Immunology and Use of Technical Words. D. L. BAILEY, W. H. BURKHOLDER, DONALD FOLSOM, M. W. GARDNER, Chm.

War Committee. J. G. LEACH, E. C. STAKMAN, I. E. MELHUS, Chm. (Executive Committee).

Temporary Committees for 1944:

Auditing. C. T. GREGORY, GEORGE B. CUMMINS, Chm.

Illustrative Material for Papers. E. D. HANSING, G. C. KENT, E. J. ANDERSON, Chm.

Publication of Membership List. R. M. CALDWELL, HELEN HART, J. G. LEACH, R. S. KIRBY, Chm.

Resolutions. R. W. GOSS, F. L. HOWARD, C. M. TUCKER, Chm.

Temporary Committee for 1945:

Publication of Special Material. H. P. BARSS, J. G. LEACH, W. H. TISDALE, W. G. STOVER, Chm.

Report of the Secretary. At the time of our Council Meeting, December 6, 1943, the membership was 1,060. It now totals (December 11, 1944) 1,089. This makes a net gain of 29 members. During the period from December 6, 1943, to December 11, 1944, 63 individuals applied for membership.

Twenty-nine former members have been reinstated, and the Society lost a total of 63 members: 16 by resignation, 9 by death, and 39 suspended for nonpayment of dues.

On January 2, 1944, a letter, one copy of the original application, the confidential slip, and new application blanks were sent to all members with applications in the Clearing Agency. Each applicant was asked to bring his application up-to-date on the new application forms and confidential slip enclosed and return to the Secretary's office. If no change was necessary, the applicant was asked to return the original copy of the application and original confidential slip.

Applications of those who did NOT return revised, or original application were removed from the ACTIVE file of the Clearing Agency. The number removed totaled 37; 20 were placed on the INACTIVE list by request, and 12 for nonpayment of dues for 1943. There are now 35 applications in the ACTIVE file of the Agency—of these 9 are new. During the year 66 applications were sent to 20 employers.

Report of the Treasurer. Statement of accounts for the year ending September 30, 1944.

Receipts:

Balance from 1943		$2296.28
Annual dues:		
1943	$ 14.00	
1944	2624.24	
1945	43.44	$2681.68
30-Year-Index		11.00
Check for collection		4.95
Sales		1.80
Total receipts		2699.43
		$4995.71

Expenditures:

Member subscriptions transferred to PHYTOPATHOLOGY:		
1943	$ 12.00	
1944	2100.50	
1945	28.50	$2141.00
Transferred to PHYTOPATHOLOGY for:		
Sales	1.80	
30-Year-Index	11.00	12.80
Secretarial work and expenses of Office of Secretary		173.05
Secretarial work for Treasurer		235.13
Printing		162.88
Stamps and envelopes		148.50
Bank service charge		3.42
Exchange charge		.50
Checks returned by bank		10.00
Telegrams		2.29
Travel expense in moving society offices, Beltsville, Maryland to Lafayette, Indiana		89.80
Total expenditures		$2979.37
Balance on hand		2016.34
		$4995.71

Sinking Fund. There has been no change in the principle amount of the sinking fund during the past year, the total remaining at $9676.00. It is invested as follows:

First mortgage note deposited with McLachlen Banking Corporation for collection ($500.00 at 4½%)	$ 500.00
United States Savings Bond, Series G, 2½%	1000.00
Invested with the following:	
Arlington and Fairfax Building and Loan Association, 4%	1000.00
Columbia Permanent Building Association, 4% (accrued interest $35.92)	535.92
District Building and Loan Association, 3½% (accrued interest $103.83)	1603.83
National Permanent Building Association, 4% (accrued interest $175.45)	2175.45
Northwestern Federal Savings and Loan Association, 3½%	2000.00
Perpetual Building Association, 4% (accrued interest $71.84)	1071.84
Prudential Building Association, 3½% (accrued interest $20.47)	196.47
	$10083.51
Less interest due PHYTOPATHOLOGY	407.51
	$ 9676.00

The Lyman Memorial Fund, obtained from voluntary contributions, now totals $3175.32. The whole amount is invested with the Brookland Building and Loan Association, at 3½%. The account for 1944 follows:

Balance on hand, December 1, 1943	$3285.83
Dividends, December 31, 1943, to June 30, 1944	99.02
	$3384.85
Less interest due PHYTOPATHOLOGY	209.53
	$3175.32

Additional Endowment:

War Savings Bonds, series F	
Received prior to December 1, 1943	$ 725.00
Received December 1, 1943, to September 30, 1944	325.00
War Savings Stamps and Cash	
Received prior to December 1, 1943	6.50
Received December 1, 1943, to September 30, 1944	.50
	$1057.00

Report of the Business Manager. The total number of nonmember subscribers was 483 on November 30, 1944, representing a net gain of 52 for the year, 1944. These consisted of 300 domestic, 32 Canadian, and 151 foreign subscribers. Included in the domestic subscriptions for later foreign shipment are 20 for the Chinese Ministry, 31 for the USSR, and 7 for the Netherlands; also 5 complimentary domestic subscriptions. There were 47 subscription cancellations and suspensions in 1944. Not included in the reported subscriptions for 1944 are 55 subscriptions for the current volume, number 34, by the American Library Association, to be held by the Society for eventual shipment to foreign countries as may be designated by the Library Association.

The sales of back volumes and issues during 1944, included in addition to smaller items amounts of: $576.00 to the Chinese Ministry of Education; $184.00 to the French Colonial Supply Mission; and $135.00 to the American Library Association.

Statement of accounts for the year ending September 30, 1944.

Receipts:

Balance from 1943			$ 6750.29
Subscriptions			
1943	$ 18.00		
1944	2548.70		
1945	288.95		
1946	116.00	$2971.65	
Member subscriptions:			
1943	12.00		
1944	2100.50		
1945	28.50	2141.00	
Sales of back numbers of PHYTOPATHOLOGY		1601.94	
Advertising			
1943	68.18		
1944	844.70		
Advertisement for membership list	50.00	962.88	
30-Year Index		68.00	
Interest on Sinking Fund			
First mortgages	21.50		
Building and Loan	100.00		
U. S. Bond Series G	25.00	146.50	
Interest on current funds		140.81	
Grant from Rockefeller Institute		600.00	
Allowance on reprints		533.27	
From authors for excess illustrations		271.05	
Smith Memoirs		.50	
Refund of overpayment		164.67	
Total receipts			9602.27
			$16352.56

Expenditures:

Printing, distributing, and storing PHYTOPATHOLOGY:			
Vol. 33, no. 11	$1079.16		
12	1026.34		
Vol. 34, no. 1	1115.88		
2	955.87		
3	783.31		
4	677.72		
5	760.27		
6	712.39		
7	712.11		
8	587.93	$8410.98	
Postage, PHYTOPATHOLOGY	309.98	$8720.96	
Secretarial work and office expense, Editor-in-chief		348.60	
Secretarial work for Advertising Manager		111.75	
Postage for Advertising Manager		9.00	
Commission for Advertising Manager (1943)		100.00	
Other expense (telephone and printing) Advertising Manager		9.68	
Secretarial work for Business Manager		314.01	
Office supplies		12.17	
Express in transferring office equipment and records, Beltsville, Maryland, to Lafayette, Indiana		61.00	

Stamps	2.50	
Printing	81.02	
Recondition typewriter	15.00	
Postage, 30-Year Index (part)	9.10	
Refund subscription	5.17	
Overcharge, Science Press	164.67	
Purchase of back numbers	14.00	
Bank charge	1.38	
Total expenditures		$ 9980.01
Balance on hand:		
Checking account	$1572.86	
Northwestern Federal Savings and Loan	4799.69	6372.55
		$16352.56

The 30-Year Index. Summary of receipts and expenditures November, 1943, to September 30, 1944:

Balance in excess of expenditures Nov., 1943	$ 59.58
Receipts Nov., 1943, to Sept. 30, 1944	68.00
	$127.58
Expenses Nov., 1943, to Sept. 30, 1944	9.10
Balance in excess of expenditure Sept. 30, 1944	$118.48

Report of the Auditing Committee, as of September 30, 1944. We have examined the books of the Treasurer of the American Phytopathological Society and of the Business Manager of PHYTOPATHOLOGY and find them to be correct.

Signed: GEORGE B. CUMMINS, *Chairman*
CHAS. GREGORY

Report of the Advertising Manager for 1944. This report covers the calendar year, January 1 to December 31, 1944. During this period 25 companies inserted a total of 122 revenue-producing advertisements in the regular journal and in the membership list. These insertions occupied 85 pages and consisted of 68 full-pages, 37 half-pages, and 17 quarter-pages. Nonrevenue-producing advertisements totalled 11 and occupied 4¼ pages involving 1 full-page, 4 half-page, and 6 quarter-page insertions relative to Phytopathological Classics, The Society Clearing Agency, 30-Year Index, Phytopathology Endowment Fund, and Biographical Memoirs of Erwin F. Smith.

Gross receipts from advertising totalled $1,685.00. The net profit to the Society after costs of printing and office expenses connected with the advertising, and agency commissions and discounts was approximately $748.00.

With the approval of the Council of the American Phytopathological Society, advertising was included in the 1944 issue of the membership list. It was largely through the efforts of the membership list committee, and J. C. Walker that enough revenue was collected from the advertising carried in the list to leave a small profit above the cost of publication.

Report of the Editor-in-Chief. There are 1085 pages, exclusive of the index, in volume 34 of PHYTOPATHOLOGY. The volume contains 106 articles, 36 notes, 3 reports of meetings, 118 abstracts, 5 biographies with portraits, 5 book reviews, 4 notices or announcements, and 224 text figures. A membership list, of 36 pages, forms a supplement to the September issue. The present editor-in-chief was appointed by the Council on March 1, to fill the unexpired term of H. B. Humphrey. Since January 1, 1944, eight papers have been rejected or withdrawn. On November 15, 1944, there were 76 papers on hand: 42 have been accepted for publication, 10 are being revised by the authors, and 24 are under consideration by the editorial board. Appraisals and criticisms are secured from two, three, or four members of the editorial board before a paper is accepted for publication.

With the approval of the Council, and for a short time, PHYTOPATHOLOGY has extended the courtesy of its pages to foreign scientists who are persevering in research under difficult war-time conditions and are deprived temporarily of opportunity for membership in the American Phytopathological Society.

The editorial board will be helped greatly and the necessity for conserving paper may be met, if authors will recognize the need for, and possibilities of, condensation. An author's condensation usually is far more satisfactory than an editor's. Tables often

can be simplified, presented in summary form, or even eliminated and replaced by a short paragraph. Illustrations may not be essential to a paper, many that are submitted cannot be reproduced well, and some do not justify the space they require. Better planning of tables and illustrations for the journal dimensions also will facilitate the work of both editorial board and printer. Conservation of space by judicious condensation will enable a greater number of members to publish in the journal.

It is gratfying to find the authors as cooperative and patient as they have been this year when it is difficult to secure adequate editorial assistance and to maintain normal publication procedures. Members of the editorial board have shared the responsibilities of the editorial office and have given invaluable assistance in the appraisal and criticism of manuscripts.

Report of Society Representative on the National Research Council for 1944. Your representative attended the Annual Meeting of the Division of Biology and Agriculture at Washington, D. C., in April, 1944. Actions and discussions of interest to the Society are as follows:

1. It was recommended to the Council that an Agricultural Board be established to which general problems relating to Agriculture can be referred. This board was subsequently created as follows: W. C. Coffey (Chairman), C. H. Bailey (Vice Chairman), R. E. Buchanan (Secretary), E. C. Auchter, T. P. Cooper, C. B. Hutchinson, W. H. Martin, L. A. Maynard, H. P. Rusk, R. F. Griggs (ex-officio), Ross G. Harrison (ex-officio). At its first meeting at Minneapolis (September 25–26, 1944) the Board undertook to sponsor the present committees of the Division which are related to Agriculture. This would include the Committee on Crop Protection (E. C. Stakman, Chairman).

2. The establishment of a subcommittee on National Research Council Fellowships in Agriculture was recommended with the idea that funds be sought to establish for the post-war period a series of Fellowships in Agriculture distinct from those now available in the Natural Sciences. This Committee has been authorized by the Council and will work in association with the Fellowship Board.

3. The Division voted to set up a Committee on Personnel Problems to consider the problems that will be faced by scientists in various fields upon demobilization of the armed forces. It was pointed out that such a committee should work with, rather than replace, systems already in existence within certain Societies (such as that in the American Phytopathological Society).

4. The question of prepublication of abstracts was discussed without any final action.

Report of the Representative to the Board of Editors, American Journal of Botany. One paper, on localization of wilt resistance in tomato, submitted for publication in the American Journal of Botany was reviewed and comments furnished to the editor-in-chief. An invitation to read a paper on certain genetic studies with an ascomycete was declined since it appeared to be somewhat out of the field of plant pathology.

As a suggestion, the question might be asked: Has the Phytopathological Society ever considered the advisability of associating with its Editorial Board representatives from certain other societies in closely related fields?

Report of Committee on Donations and Legacies. One appeal went out to the entire membership to purchase war bonds and stamps, or make contributions to The American Phytopathological Society for the purchase of bonds and stamps, to enhance the Lyman Memorial Fund. The response was almost negligible, since during the entire fiscal year only one contribution had been made from an individual in the form of a Series F Bond with a maturity value of $25.00. In addition, the Pacific Coast Division of The American Phytopathological Society had contributed three Series F Bonds each with a maturity value of $100.00.

Your Committee has had considerable correspondence relative to the possible reasons why our membership did not respond to these appeals over the past two years in a more generous fashion than they did. Very evidently, the cost of the appeals to the membership did not bring in results commensurate therewith.

It would be the chairman's recommendation that the Committee be completely reorganized with new personnel which will bring new viewpoints and new ideas to it. It would also be the chairman's recommendation that Mr. N. J. Giddings, who is responsible for the Pacific Coast Division contributions, be made the permanent chairman of this Committee. During the past two years he has shown a high degree of interest in the Committee's activities and will ably continue its work.

J. G. BROWN, N. J. GIDDINGS, B. L. RICHARDS,
N. E. STEVENS, R. P. WHITE, Chairman

Report of the Extension Work and Relations Committee. A kodachrome transparency exchange has been instituted and has resulted in the distribution of 3,818 slides on

vegetable diseases, 1,197 slides on fruit diseases. In 1944 a set of cereal disease transparencies was collected and an opportunity presented to most Plant Pathologists to select and secure copies for their own educational work. It is hoped that this visual educational material will result in better farmer education in disease control.

A manual of extension methods in Plant Pathology was prepared by a group of pathologists under the supervision of Dr. Haskell and distributed to Plant Pathologists and heads of Extension work throughout the United States and Canada. During the past year further distribution to workers in foreign countries has continued on a request basis.

The exchange of pertinent control articles, mimeographs and printed matter, has continued in an attempt to bring the new work to the attention of those interested.

A movement has been started to assemble pictures, diagrams, and drawings of disease specimens for exchange (much as the transparencies have been). The sub-committee feels the need of better illustrations in pathological control literature and would welcome suggestions as to (1) a method of securing adequate illustrative material, and (2) a means of making this material available for State use.

Report of the Necrology Committee. Deaths of members during 1943 not previously reported:

JAMES MCMURPHY (date not known)
G. W. GOLDSMITH, August 28

Deaths of members during 1944:

DEAN B. SWINGLE, January 8
P. H. ROLFS, February 23
W. T. HORNE, April 12
A. H. R. BULLER, July 3
E. F. GAINES, August 17
ERNEST DOPP, September 24
H. H. WHETZEL, November 30

Report of the Manager of Phytopathological Classics. Report for the fiscal year beginning December 1, 1943, and ending September 30, 1944:

Classics No. 1:	On hand Dec. 1, 1943	23	
	Sold during year	8	
	On hand Sept. 30, 1944		15
Classics No. 2:	On hand Dec. 1, 1943	223	
	Sold during year	7	
	On hand Sept. 30, 1944		216
Classics No. 3:	On hand Dec. 1, 1943	314	
	Sold during year	8	
	On hand Sept. 30, 1944		306
Classics No. 4:	On hand Dec. 1, 1943	374	
	Sold during year	8	
	On hand Sept. 30, 1944		366
Classics No. 5:	On hand Dec. 1, 1943	614	
	Sold during year	10	
	On hand Sept. 30, 1944		604
Classics No. 6:	On hand Dec. 1, 1943	696	
	Extras found	7	
	Sold during year	11	
	On hand Sept. 30, 1944		692
Classics No. 7:	On hand Dec. 1, 1943	718	
	Extras found	10	
	Sold during year	12	
	On hand Sept. 30, 1944		716

Receipts:

Cash balance on hand Dec. 1, 1943	$442.28	
Receipts during year	42.50	
Total		$484.78

Expenditures:

Postage	$ 5.75	
Stationery	16.00	
Total expenditures		$ 21.75
Balance on hand Sept. 30, 1944		$463.03
Due on accounts Sept. 30, 1944		21.50

Report of the Public Relations Committee for 1944. Slight changes in policy, with a view of greater decentralization of responsibility and more evenly divided territorial spread have been applied through the committee membership with varying success. Probably further changes would be beneficial, particularly in regard to including in unit areas lands geographically contiguous and producing similar crops.

The responsibility and actual work of the committee, previously largely carried by the chairman, has been passed on to the committeemen in their respective geographical areas largely because of the diversity of crops and likewise the wide range of application of the technical material contained in PHYTOPATHOLOGY throughout the year.

The scope of the work has been slightly enlarged and the reception probably better. Local spreads in various localities in daily newspapers, Sunday supplements, and farm magazines have been spasmodic but increasingly impressive. For instance, several pages of plant diseases and fungi in colors have appeared in different magazines of national distribution and scope during the past year.

The general response of the society members as to their opinions and reactions to this activity appears definitely to be increasingly favorable and voluminous. The necessity and importance of this work in relation to the general welfare of the society and its members as individuals have frequently been manifested. In the past, we as a group have probably suffered less rapid progress because of our reluctance to devote at least a small portion of our time and energy explaining to the public the scope of our work and its application. It can hardly be denied that any business successfully conducted devotes certain of its energies informing the people. It is the general belief of the committee that the field and scope of phytopathology has been more successfully interpreted and understandingly placed before the general public than any year of the past in spite of the continued competition in publicity due to the war.

Some changes in personnel have been made and others should be made whenever any member is found with ability to popularize our technical findings.

Report of the Committee on Regulatory Work and Foreign Plant Diseases. The standing committee on Regulatory Work and Foreign Plant Diseases, consisting of C. R. Orton, R. P. White, and E. C. Stakman, chairman, has little to report. Dr. White was acting chairman while the chairman was in Mexico during the spring of 1944.

There are now in reality three committees or subcommittees, representing more or less directly the Society, that are concerned with quarantines and regulatory work:

1. The subcommittee of the War Committee, known as the plant quarantine subcommittee
2. The Crop Protective Committee of the National Research Council
3. The standing committee

The activities of committee No. 1 will be summarized in the report of the War Committee. Committee No. 2 was authorized at the Columbus meeting to represent the interests of the Society in matters affecting entomology and plant pathology jointly. Committee No. 3 was authorized at the Columbus meeting, and its function was restricted to giving advice, when called upon, to the federal Bureau of Entomology and Plant Quarantine.

Committee No. 2 concentrated on an attempt to get the U.N.R.R.A. to take all feasible precautions in preventing the promiscuous dissemination of insect pests and plant pathogens. In spite of the fact that the committee actually put forth considerable effort, the results were somewhat disappointing, although the officials of this organization probably have consulted more freely with the federal Bureau of Entomology and Plant Pathology than might otherwise have been the case. Perhaps, after all, the committee could not go very much farther than to influence the U.N.R.R.A. organization to avail themselves of the help and advice of official organizations charged with the responsibility of safeguarding against the introduction of new or especially dangerous pests and pathogens.

As concerns the activities of Committee No. 3 specifically, the federal Bureau of Entomology and Plant Quarantine furnished information regarding the important plant diseases taken in connection with insect and plant disease surveys in the general vicinity of ports of entry from June, 1943, to December 31, 1943, and consulted with the committee regarding the potato wart situation in the United States. Inasmuch as committees 1 and 2 concerned themselves with attempting to get proper action, committee No. 3 restricted its function to its mandate, namely, to give advice when the advice was sought.

Report of the Committee on Biological Abstracts and the Union of Biological Societies. In general, the present picture for BIOLOGICAL ABSTRACTS is a good one: The enterprise is holding its own and in some respects improving and advancing in spite of the continuing difficulties of the hour. As with most current activities—governmental and private—this is the critical moment to continue full speed ahead and at the same time to plan for the post-war period.

Abstracts of Plant Sciences. The complete volume of Biological Abstracts for 1944 will contain 23,314 abstracts as compared with 25,947 in the preceding year; Secton D—Abstracts of Plant Sciences will contain 5,701 this year as compared with 6,516 in 1943. This section includes: Ecology, systematic botany, morphology and anatomy of vascular plants, agronomy, horticulture, forestry, pharmacognosy and pharmaceutical botany, plant physiology, and phytopathology. For the year it contains 1,277 abstracts of contributions dealing directly or indirectly with plant diseases, three-fourths of which are in the division devoted to plant pathology so ably edited by Dr. Freeman Weiss.

Current output of published research. One feature of the times is that a large amount of scientific activity still going into research cannot—for military reasons—be published now. Furthermore, many of the active scientists of the warring nations are in the armed forces or in one way or another serving their governments in capacities precluding further current research or the publication of that already completed; this situation also renders many of those who formerly cooperated with Biological Abstracts unavailable for abstracting or for other essential services to the journal. The research literature available is therefore somewhat smaller than in recent years, yet Biological Abstracts continues to abstract all that is obtainable promptly and with unimpaired scholarship. At the present time about 2,000 journals are being covered, and cooperation with other American and British abstracting services is continuing.

Efforts directed toward the procurement of European journals for abstracting have gone on vigorously in spite of difficulties which all will recognize. More recently, about 170—mainly German and medical—are available for this purpose and are being abstracted as rapidly as possible. Active efforts are also being made to procure and abstract the literature of Russian research. For a number of years only a small trickle of this material has been obtainable, but recent weeks have seen an encouraging increase in the flow.

Post-war publication. In the months that will follow the conclusion of the war in Europe, Biological Abstracts will undoubtedly face one of its greatest tests. Current indications seem to be that there are at least 2,500 and possibly as many as 3,500 European publications, unavailable since the onset of the war, which should be abstracted at once. This includes the bulk of the German literature and nearly all of the French, Italian, Scandinavian, Dutch, Belgian, and Swiss. The policy of Biological Abstracts will be to procure these journals and abstract them from the beginning of the war, but stocks of such publications available for export are scant and the procurement, assignment, and abstracting of this vast amount of material are bound to present major difficulties. The Trustees and Staff of Biological Abstracts solicit the advice, assistance, and cooperation of all to help them carry out this program promptly and in a scholarly manner.

Financial status. Thanks to a steady increase in the number of subscriptions and to the generosity of nearly 100 industrial corporations, supplementing previous channels of income, the organization expects to complete the year substantially with a balanced budget. Estimated income for 1944 will be approximately as follows: Subscriptions $49,460.18, advertising income $2,428.04, net from sale of back volumes $6,010.96, and contributions from societies $3,049, making with contributions of $12,770 from the industries a grand total of $73,718.68; the operating budget for the year was $72,740. Considerable satisfaction is justifiable from the fact that Biological Abstracts is now running on budgets that are substantially in balance with income slowly growing from year to year. It should not be forgotten, however, that this situation is very largely due to the generous subsidies received from corporations in the biological field—about a sixth of the total budget. Except for their help Biological Abstracts would be forced to draw on its meager reserve and also to curtail its publication. While these corporations undoubtedly value Biological Abstracts and want to assist, it should be remembered in estimating the future stability and growth of Biological Abstracts that these contributions—mostly in the form of $100 gifts, in some cases as much as $500—are commitments for one year only and that there is no absolute assurance that such support will continue indefinitely. Up to 80 per cent of such gifts can now be deducted in figuring income taxes. How a post-war decline in the prosperity of the corporations or a change in the tax laws might affect the present attitude is a question. Biological Abstracts cannot safely rely on contribution subsidies as a permanent basis of income; it is now therefore up to all biologists to make every effort toward increasing institutional, departmental, and personal subscriptions as a basis for adequate permanent support.

Subscriptions continue to increase slowly but steadily; the income to the current volume from this source stands about $6,200 more than a year ago, the number of sub-

scriptions for the complete edition having increased by 203 (98 domestic, 105 foreign) and that for the sectional subscriptions by 209 during 1944. American subscriptions to Section D (Plant Sciences) have increased from 385 to 403.

Lest we forget. To sum up the situation, Biological Abstracts has in 1944 added another creditable volume, abstracting the current literature of biology insofar as it has been available, has gone through the year substantially on a balanced budget, has materially increased its subscription income, and is looking toward the future with confidence. Year by year an instrument is being fashioned that is destined to become a progessively more important and more perfect tool for the increase, diffusion, and application of man's knowledge in the life sciences.

Biological Abstracts gratefully acknowledges the fine cooperation of its 3,000 collaborators and 150 section editors which has made its achievements possible despite the smallness of its central office staff. At the present time the Business Manager and his secretary, two central office editors (Dr. John E. Flynn, Editor-in-Chief, and Dr. Jean MacCreight, Assistant Editor), and two proofreaders are included in a total editorial office staff of twelve. Their accomplishment is an example of effectiveness that requires no comment and merits the appreciation of all.

Report of the Committee on Resolutions. BE IT RESOLVED THAT The American Phytopathological Society express its grateful appreciation to the following for their contributions to the success of its 36th annual meeting and war conference:

a. The Committee on Arrangements consisting of: W. D. Valleau, Chairman; Stephen Diachun, E. M. Johnson, A. J. Ullstrup, and O. T. Wilson for its services in providing many conveniences.

b. The management of the Netherland Plaza, and especially Miss Mary M. Hesse, Otto Hecker, and William P. Pfeiffer for their interest in making adequate facilities available.

c. The newspapers: Cincinnati Times-Star, Cincinnati Post, and Cincinnati Enquirer for their effective handling of news coverage.

d. The Cincinnati Chamber of Commerce for its courtesy in providing assistance in registration.

e. Mr. Harry R. O'Brien for his preparation of news releases.

f. The Ohio State University for the use of projection equipment.

g. Mrs. Jeanne Valleau Gaines, and R. R. Kincaid for adding interest and enjoyment to our annual dinner.

BE IT RESOLVED THAT the Society express its gratitude to the retiring Secretary, C. C. Allison, for his efficient performance of the duties of the office during the past three years, and to Miss Marjorie L. Jones for her capable assistance.

BE IT RESOLVED THAT the Society express its gratitude to H. B. Humphrey for his services as editor-in-chief of PHYTOPATHOLOGY from 1929 to 1944. His untiring efforts have established for the Journal a reputation as one of the outstanding publications in the field of plant science.

BE IT RESOLVED THAT the Society express its appreciation to Livia Appel, P. K. Baird, C. A. Peerenboom, J. B. Schramm, and W. A. Sumner for contributing data and advice on publication problems.

Respectfully submitted,
R. W. GOSS
F. L. HOWARD
C. M. TUCKER, Chairman

ACTION TAKEN BY THE COUNCIL AND SOCIETY AT THE 1944 ANNUAL MEETING

Elections and Appointments. A committee, appointed by the Council, opened and counted the ballots, results of which were announced to the Society at the banquet the evening of December 10: H. B. Humphrey, President; J. H. Craigie, Vice-President; R. W. Goss, Councilor at large.

The Council recommended and the Society approved the appointment of E. M. Johnson, Secretary, for a three year term, 1945 through 1947; Paul E. Tilford, Advertising Manager of PHYTOPATHOLOGY, for a one year term; and L. C. Knorr, Editor and Acting Manager of Phytopathological Classics.

Representatives of the Society, new committees, and changes in committee personnel are given on pages 262 and 263.

Sixty-three applicants were elected to membership in The American Phytopathological Society.

Reports of Officers, Representatives, and Committees. Reports of officers, representatives, and standing committees are published on pages 263–271. According to action of the Society at the Philadelphia Meeting reports of Special and Temporary Committees

are not to be published in the annual report. All committee reports submitted were considered by the Council. The reports recommended for approval by the Council, with slight changes in some cases, were accepted by the Society.

The Society approved the following recommendations made by the Council.

1. Contribution of $50.00 to the Union of American Biological Societies and Biological Abstracts.

2. Commend members of the membership list committee for their excellent work and recommended that the next Council consider publication of a revised membership list in 1946.

3. Appointment of a Standing Committee called "Placement Committee" to continue the work of the Clearing Agency formerly handled by the Secretary.

4. Acceptance of a resolution relative to the importance and need of continuation of the work of the Emergency Plant Disease Prevention Program submitted to the Council by the War Committee.

5. That the incoming President appoint a temporary committee "to study and recommend ways and means of providing for publication by the Society of useful articles not otherwise provided for with the suggestion that this committee consider underwriting acceptable publications to be sold at approximate cost to reimburse and gradually increase the Society's backlog."

6. Action of the Council taken early in 1944 in accepting the resignation of H. B. Humphrey, editor-in-chief of PHYTOPATHOLOGY, and the appointment of Helen Hart to finish the unexpired term as editor-in-chief.

7. Appointment of E. J. Anderson, L. M. Black, F. L. Howard, and C. M. Tucker as associate editors of PHYTOPATHOLOGY for a three-year term. Appointment of L. R. Tehon as associate editor of PHYTOPATHOLOGY for 1945 and 1946; appointment of M. W. Gardner as associate editor of PHYTOPATHOLOGY for 1945. In arranging for nonconcurrent terms for the editors of PHYTOPATHOLOGY the resignation of A. J. Riker, whose term would ordinarily expire at the end of 1946, was accepted and he was reappointed for a three-year term beginning 1945.

8. Standing Committe on "Recognition of Merit" be discontinued.

9. Accept and place in effect the following recommendations presented by the Special Committee on "Publication Problems":

Place in effect as soon as possible with the present printer, Science Press, economies regarding (1) paper, (2) vertical lines in tables where this saves money, and (3) publishing in units of 16 pages in accord with its quotation of November 10. The increased cost of printing notwithstanding these quotations will provide approximately the same number of pages in 1945 as in 1941 for the same outlay.

Authorize the business manager and editor-in-chief to make the change at the end of a volume to a double column format, in accord with the answered questionnaires, when an over-all saving of more than 10 per cent can thus be accomplished. It takes a year or two for authors, editors, and printers to make such a change smoothly.

Ask the Society to vote the editorial staff a mandate "to sharpen editorial pencils," to employ at least two qualified and anonymous referees on each manuscript, and to improve the quality of manuscripts through suggestion and encouragement, as far as possible, and through rejection when necessary.

Authorize the preparation and publication of "Suggestions to Writers."

Charge the authors for excessive changes from galley copy at the discretion of the editor-in-chief.

Print and distribute annually, or set up as a standing page and print on otherwise blank pages, the suitable form with which a member could add a codicil and remember the Society in his will. This might provide a substantial income.

Create a class of sustaining contributors at $100.00 per year open to industrial companies and publish the list with each number. The Society of American Bacteriologists has 60 sustaining members. The list is published with each number. A standing committee might be charged with the duty of keeping the list alive. (J. J. Christensen was selected by the Society to handle this in cooperation with the Committee on "Donations and Legacies.")

Arrange for the collection of dues in the fall and for delinquent members to have their journal stopped after the January number. This will preserve the supply of most back numbers in whole volume units, which are more valuable than units from May to May.

10. Recommended after a study of its report that the committee on Society Organization be made a Standing Committee to continue a study of the revision of the Constitution and to make specific recommendations to the Council for presentation to the Society according to the Constitution.

11. Recommended that no summer meeting of the Society be held, and leave the matter of time and place of the next annual meeting to the decision of the Council.

ARTHUR HENRY REGINALD BULLER

August 19, 1874 — July 3, 1944

Professor A. H. Reginald Buller was graduated from the University of London in 1896 with the degree of Bachelor of Science and received the degree of Doctor of Philosophy in 1899 from the University of Leipzig, Germany. The honorary degree of Doctor of Laws was bestowed upon him by the University of Manitoba in 1924, by the University of Saskatchewan in 1928, and by the University of Calcutta in 1938. Pennsylvania University granted him the degree of Doctor of Science in 1933.

From 1901 to 1904 Dr. Buller was lecturer in botany at the University of Birmingham; in 1904 he went to the University of Manitoba at Winnipeg as professor of botany, where he remained until his voluntary retirement as professor emeritus in 1936. He also held a number of special lectureships in the United States: he was Norman Wait Harris Foundation lecturer at Northwestern University in 1927, summer lecturer at Louisiana University in 1941, Hitchcock professor at California in 1942, and in the same year Schiff Foundation lecturer at Cornell.

Dr. Buller was a member of the American Phytopathological Society. His contributions to the field of mycology are so extensive, important, and well known as scarcely to require comment. Probably most notable among his contributions are those on spore formation, spore liberation, and sexuality.

ERNEST ADAM DOPP

September 12, 1896 — September 24, 1944

Ernest Adam Dopp was graduated from the University of Wisconsin in 1922 with the degree of Bachelor of Arts, and received the degree of Master of Arts in 1924 from the same institution.

Mr. Dopp was Assistant in Botany, University of Wisconsin, 1922–23; Instructor in Botany, University of Minnesota, 1924–1927, and Instructor, La Crosse (Wisc.) Normal, 1927. From 1928, Mr. Dopp served in the Bureau of Plant Industry, U. S. Department of Agriculture, as Junior Pathologist, 1928–1929, and Assistant Pathologist, 1929 to the time of his death.

Mr. Dopp was of a quiet, pleasant disposition, very modest but always most helpful to his colleagues, and thus he was a most valuable member in the various cooperative researches in which he had a part.

EDWARD FRANKLIN GAINES

January 12, 1886 — August 17, 1944

Dr. Edward Franklin Gaines was graduated from the State Normal School, Cheney, Washington, in 1907. Following a limited experience as a public school teacher, he entered the State College of Washington, where, in 1911, he received his B.S. degree. The same institution granted him the degree of Master of Science in 1913. From Harvard University he earned the Sc.D. degree in 1921.

Dr. Gaines joined the staff of the State College of Washington in 1911, under appointment as Instructor in Agronomy and as Assistant Cerealist in the Experiment Station. In 1917 he was promoted to the rank of Cerealist, and in 1930 was appointed Professor of Genetics.

Early in his experience in agronomy and plant pathology Dr. Gaines became interested in the cereal smuts and especially in the nature and control of bunt of wheat, a smut that had long exacted a heavy toll from the farmers of Eastern Washington and adjacent States. To him chiefly is due the credit for production and improvement of such bunt-resistant varieties of wheat as Ridit, Albit, and Hymar. The variety Hymar is now the most important winter wheat grown in Eastern Washington.

To his intimate friends Dr. Gaines was more than an outstanding teacher and investigator. He believed in mankind, and devoted such time as he could to the social and cultural betterment of young people. He radiated integrity, loyalty, and a rare steadfastness of purpose. He will long be remembered for his scientific attainments but longer still for his influence for good and as a man among men.

WILLIAM TITUS HORNE

November 8, 1876 — April 12, 1944

William Titus Horne was graduated from the University of Nebraska in 1898 with the degree of Bachelor of Science and was a Fellow in Botany at Columbia University, 1903–04.

Professor Horne was Instructor in Botany at Nebraska Wesleyan University, 1898–1900, and also at the University of Nebraska, 1899–1900. He was Assistant Plant Pathologist, 1904–1907, and Chief Plant Pathologist, 1907–1909, Estacion Central Agronomica, Santiago de las Vegas, Cuba; Assistant Professor of Plant Pathology, University of California, 1909–1914; Associate Professor, University of California, and Associate Plant Pathologist, California Agricultural Experiment Station, 1914–1939; and Professor of Plant Pathology and Plant Pathologist in the same institutions, respectively, from 1939 to the time of his death.

Professor Horne was a man of unusually pleasing personality and a most capable teacher and wise counselor in research. He made notable contributions in his own researches on difficult problems. The memory of his congenial companionship will linger in the hearts of his many friends.

PETER HENRY ROLFS

April 17, 1865 — February 23, 1944

Peter Henry Rolfs was graduated from Iowa State College with the degree of Bachelor of Science in 1889, and received the degree of Master of Science in 1891. The degree of Doctor of Scince was conferred on him by the University of Florida in 1920.

He was Professor of Natural Science at Florida Agricultural College from 1891 to 1899, Botanist and Bacteriologist at Clemson College 1899 to 1901, Plant Pathologist in the U. S. Department of Agriculture 1901 to 1906, Director of the Agricultural Experiment Station of the University of Florida from 1906 to 1921. He developed and was Director of the Escola Superior de Agricultura Vicosa, Brazil, 1921 to 1933. He was Consultor de Agricultura in Minas Geraes, Brazil, from 1928 to 1933.

Professor Rolfs was a charter member of the American Phytopathological Society. He was a pioneer in mycology and plant pathology, an interest in which he retained throughout his career, along with his wide horticultural activities. He contributed much to his associates in inspiration and stimulation of research, and to agriculturists in general in his dissemination of practical knowledge.

DEANE BRET SWINGLE

June 6, 1879 — January 18, 1945

Deane Bret Swingle was graduated from Kansas State Agricultural College in 1900 with the degree of Bachelor of Science and received the degree of Master of Science in 1901 from the University of Wisconsin and the degree of Doctor of Philosophy in 1931 from the same institution.

From 1901 to 1906 Dr. Swingle was employed in the United States Department of Agriculture, assisting Dr. Erwin F. Smith, and from 1906 to the time of his death he was connected with the Montana State College and Montana Agricultural Experiment Station. He organized the work in botany and bacteriology and in 1911, when this was recognized as a department, Dr. Swingle was made its head, in which position he remained until the time of his death. In the earlier years he also served as Acting President of the college, and in the later years, until his death, he was the Vice-president.

Dr. Swingle was charter member of the American Phytopathological Society, and was a member of a number of other scientific and social organizations. He made notable contributions in the fields of botany, bacteriology, and plant pathology; and was always a valued, sympathetic counselor to students and faculty members. Thus he erected his own memorial in the hearts of his friends.

HERBERT HICE WHETZEL

September 5, 1877 — November 30, 1944

Herbert Hice Whetzel was graduated from Wabash College at Crawfordsville, Indiana, in 1902, and pursued graduate work at Cornell University from 1902 to 1906. Wabash College gave him a Masters degree in 1906 and the honorary Sc.D. degree was destowed on him by the University of Puerto Rico in 1926 and by Wabash College in 1931.

In 1906, Professor Whetzel was appointed an assistant professor and head of a new department of botany in the New York State College of Agriculture, the name of which was changed to department of plant pathology the following year. He was appointed professor of plant pathology in 1909 but resigned his position as head of the department in 1922 in order to devote his full time to teaching and research at which he continued the remainder of his life.

Professor Whetzel was a charter member of the American Phytopathological Society, its president in 1915, and chairman of its War Emergency Board in 1918. He promoted the organization of the Mycological Society of America and was its president in 1939. He was also a member of the Botanical Society of America, of the British Mycological Society, and of several honorary societies.

Professor Whetzel possessed great energy, persistence, and enthusiasm. He was a unique character with extraordinary talents. An excellent teacher, a productive investigator, a forceful speaker, his influence was felt by students, colleagues, and friends alike and his death will be mourned by all.